Royal palms at the Lamao Experiment Station, Lamao, Bataan.

THE PHILIPPINE

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## IMPROVING THE QUALITY OF ABACA.

This matter is again been brought to the attention of abacá producers, especially of those in the provinces of Albay and Camarines. The producers in these provinces and also those in some districts of other provinces, where the bulk of production is of the grades "Coarse" and below, are experiencing hard and trying times due to the lack of a market for their product. This condition is by no means new as it has obtained several times in the past, although the causes responsible for its recurrence at this time are not altogether identical with the previous ones.

This Bureau, during the last fifteen years or more, has repeatedly advocated the production of abacá fiber of a higher quality. The fiber specialists of the Bureau have always maintained that abacá should never be produced below the quality of "Good fair," and all countries purchasing fiber inferior to the above grade should be educated in the use of the higher qualities. The reasons for advocating a higher level of quality to the extent mentioned above are based on the fact that the abacá fiber of the grades "Good fair" and above possesses excellent qualities, such as strength, elasticity, and durability, in which it cannot meet with any serious competition from other hard cordage fibers.

If owing to the present imperfect method of extracting the abacá fiber and the various and scattered localities in which it is produced, the above improvement is considered too radical or impracticable at the start, it may be possible to modify this to the extent of making the grade "Medium" the lowest level of production. This will always allow of the production of sufficient quantities of cheap fiber to supply the demand in British and other European markets.

Space does not permit of a thorough and detailed statement regarding the benefits of such improvement in quality, but it is considered important to mention that the objection often raised to the above plan to the effect that it will result in an overproduction of a high-grade fiber and a consequent decline in the value of such grades, cannot be seriously considered, for

the reason that the elimination of the grades "Coarse," "Coarse brown," "Daet coarse," and "Daet coarse brown," will correspondingly increase the actual demand for the higher grades. In addition, if these grades are eliminated, the increase in production of the higher grades will be less than the decrease caused by the elimination of the coarse and woody grades. For example, if during normal years the annual production of the coarse and woody grades amounts to 380,000 bales, this same quantity when prepared so as to average between "Midway" and "Good fair," will not amount to more than 200,000 bales. Furthermore, the coarse and woody grades are almost entirely purchased by manufacturers in Great Britain, while with the elimination of these grades, all the markets of the world will have to buy the higher grades, and thus competition will serve to maintain at all times a reasonably high level of prices for these grades.

# THE TOBACCO LAW, ACT 2613.

By A. M. BURTON, *Acting Chief, Plant Industry Division.*

On February 4, 1916, the Philippine Legislature passed an act having as its object the improvement of methods of production and the quality of tobacco in the Philippine Islands and the development of the export trade therein. By the provisions of this act three governmental agencies, the Bureaus of Internal Revenue, Forestry, and Agriculture, work together to improve the tobacco industry. Briefly, the functions of each governmental unit are as follows:

## THE BUREAU OF AGRICULTURE.

1. To acquire and distribute to growers, through its inspectors, cleaned seed of well-developed tobacco plants of good type.
2. To furnish plans and specifications for the construction of standard tobacco-curing sheds. In this phase of the work the Bureaus of Agriculture and Forestry coöperate, the Director of Forestry having appointed the tobacco inspectors of the Bureau of Agriculture as special forest officers and having authorized them to issue gratuitous permits to tobacco planters for the cutting of timber for the construction of curing houses.
3. To appoint the necessary tobacco inspectors to carry out the provisions of the act.
4. To classify planters as first and second class and grant diplomas to growers for excellence of product.

## THE BUREAU OF INTERNAL REVENUE.

1. To offer prizes for new remedies for tobacco pests.
2. To establish general and local rules respecting the classification, marking and packing for both domestic use and export.
3. To establish standards for export tobacco.
4. To require, when deemed expedient, the inspection and labeling of tobacco removed from its province of origin. The general provisions of the law are as follows:

(1) No tobacco shall be exported from the Philippine Islands except that inspected and certified to by the Collector of Internal Revenue.

(2) Fees of \$0.15 per 1,000 for cigars, \$0.01½ per 1,000 for cigarettes and \$0.02½ per kilo for leaf tobacco shall be charged for such inspection.

(3) Tobacco inspectors may be appointed by the Collector of Internal Revenue to carry out the above provisions, also two publicity agents to be detailed to the United States.

(4) Condition of Government-inspected cigars and cigarettes shall be guaranteed by the Insular Government.

(5) The Collector of Internal Revenue shall facilitate the free entry of inspected tobacco products into the United States by certifying to their origin, thus gaining admission free of customs duties. Tobacco not so inspected and graded shall not be issued such certificate of origin. Additional sections provide for the administration of the Act, disbursement of funds, and make an initial appropriation of \$7,500 for the purpose of carrying out the provisions of the law.

In the carrying out of the provisions of this law relating to the activities of the Bureau of Agriculture, two more or less distinct phases are encountered. The first is the demonstration work with the farmers. In carrying out this part of the work, the Bureau inspectors travel through the tobacco districts, each inspector being assigned to a fixed district, and through coöperation with farmers, lectures, and conferences carry direct to the growers the doctrine of improved methods of cultivation and curing. These traveling inspectors are also special forest officers and as such, encourage the people in the erection of drying sheds and issue free licenses for the cutting of timber for the construction of curing sheds. From the inauguration of the law up to November 30, 1916, licenses had been issued as follows:

Province of Cagayan: Municipality of Tuguegarao, 109 licenses; Peñablanca, 147; Amulung, 119; Tuao, 8; Alcala, 16; Baggao, 23; Iguig, 1.

Province of Isabela: Municipality of Echague, 40 licences; Angadanan, 43; Santa Maria, 67; San Pablo, 40; Ilagan, 56; Tumauini, 37; Cauayan, 18; Reina Mercedes, 1; Gamu, 50; Naguilian, 71.

The second and equally important phase of the activities of the Bureau of Agriculture in connection with the improvement of the quality of tobacco is the production and distribution of the best grade of seed. In August, 1916, the Emergency Board of the Philippine Commission allotted the sum of \$5,050 for the establishment of a tobacco-testing station. Subsequently a site was selected at Dammao, Gamu, Isabela Province, and a station

established. This station is on the Cagayan River. On December 23, 1916, there had been constructed on the station the following buildings: Seed and tool house, 4 by 6 meters; storehouse, 9 by 6 meters; assistant superintendent's house, 11 by 8 meters; and work on the superintendent's house, 12 by 9 meters, was well under way. In addition, 14 hectares of land had been cleared and plowed and 50 cubic meters of earth removed in making a river landing. Twenty experimental plots, 4 by 10 meters, had been prepared, six planted and 10 additional hectares prepared ready for transplanting. Owing to heavy continuous rains, field transplanting could not be started as early as was hoped. The object of this station is to isolate from the vast mixture of tobaccos now growing in the valley the best existing strains, and, through inbreeding, build up and fix the finer strains and produce sufficient seed thereof to supply the planters. Work is at present being carried on with five different varieties; Texas-Cuban, Sumatra, Connecticut-Havana, Vuelta abaja and the Tirona-hybrid. The tobacco station is under the immediate supervision of Mr. Thos. R. Manus who has spent fourteen years in the Cagayan valley and is thoroughly familiar with all the phases of tobacco production. Dr. C. F. Baker, of the College of Agriculture, University of the Philippines, who has had years of experience in scientific tobacco work in both Cuba and the Philippines, has kindly volunteered to act in an advisory capacity in carrying on the work at this station.

Another line of work being carried on by the Bureau of Agriculture, which, while not specifically a part of the tobacco law, has as its object the improvement of the industry, is the control of the tobacco weevil and mold. A vacuum machine designed by Mr. D. B. Mackie, entomologist of the Bureau of Agriculture, has been installed in one of the large factories of Manila and has given exceptionally satisfactory results, being economical in operation and capable of handling large quantities of tobacco, either as leaf tobacco or as cigars or cigarettes. As an article will soon be published regarding this machine, details will be omitted here.

The result of that portion of the law pertaining to curing and inspection cannot now be stated as a crop has not been harvested since the law went into effect. However, the law has provided for publicity work in the United States, and the effects of this are already noticeable in the large amount of advertising which Philippine cigars are receiving, accompanied by a corresponding increase in the export trade.

# NEW OR NOTEWORTHY TROPICAL FRUITS IN THE PHILIPPINES.[1]

By P. J. WESTER, *Horticulturist in Charge of Lamao Experiment Station.*

## PRELIMINARY REMARKS.

Plant introduction has been a prominent feature of the work of the Bureau of Agriculture since its inception, and special attention has been given to the importation of species and varieties of fruits during the last six years, which have been assembled at the Lamao experiment station together with a large number of the indigenous and long-since introduced species. Few of these plant immigrants have failed absolutely, a great majority have responded well to the climate and to the care given them, and quite a number have already fruited, some of which are now being propagated for general dissemination throughout the Archipelago, and promise to become valuable additions to the Philippine fruits. A few of these new introductions are discussed below, as well as three Philippine fruits that are well worthy of attention even in countries outside of their origin.

The plates illustrating the flowers of the biriba and the fruit of the bael, biriba, genipa, ketembilla, maron, paniala, pereskia and Siam, have been made from material grown at the Lamao experiment station. The plate illustrating the fruit of the yaruma is published through the courtesy of Mr. David Fairchild, Bureau of Plant Industry, United States Department of Agriculture.

## DESCRIPTIONS AND COMMENTS.

**BAEL,** *Aegle marmelos* Corr. RUTACEAE. (Pl. II (*a*).)

A small, rather handsome tree about 7 meters high; when young, with stout, sharp spines throughout, on the full grown tree the slender and drooping branches being usually spineless; leaves trifoliate, from 12 to 17 centimeters long, glabrous, dark green; flowers small, greenish and very fragrant, in few flowered,

[1] For previous papers of this character see this REVIEW, VOL. V (1912), p. 593; Vol. VI (1913), p. 493; and Vol. VIII (1915), p. 103.

terminal, loose clusters. The fruit is large, 7.5 to 10 centimeters in diameter, weighing from 300 to frequently exceeding 550 grams; form variable, from roundish oblong to spherical and oblate, base usually nippled; surface smooth, bluish green, changing to yellowish, usually mottled; the pulp, which is enclosed in a hard, bony shell 2 to 3 millimeters thick, is of a rich creamy-yellow color, soft, containing a few coarse fibers, rich, sweet, rather cloying to the occidental palate, very aromatic, recalling the raspberry; seeds many, contained in several long locules filled with a resinous gum.

The fruit ripens from February to May, remaining on the tree for nearly a year.

Dr. H. C. Brill, chief of the division of organic chemistry, Bureau of Science, has made the following analysis of the bael:

| | Per cent. |
|---|---|
| Protein (N × 6.25) | 2.62 |
| Sugar | 5.80 |
| Acid (as tartaric) | 2.11 |
| Other nitrogen-free substances | 28.11 |
| Insoluble | 5.36 |
| Ash | 1.04 |

The edible portion constitutes 52 per cent of the weight of the fruit.

The bael is of Indian origin and has long been cultivated from India to Burma, and is mentioned by several of the early travelers to the East. It is now fairly well introduced into most tropical countries, though not generally cultivated.

The bael was first introduced into the Philippines by the late Mr. W. S. Lyon when he was horticulturist of this Bureau, and fruited for the first time at Lamao in 1914, the trees being quite prolific. In eating qualities the fruit is quite similar to, but of richer flavor and softer than, the mabolo, and is considered a specific for dysentery. For a tropical fruit the bael has remarkable keeping and shipping qualities.

According to Watt, in Burma improved varieties of the bael are propagated from root cuttings. At Lamao it has been demonstrated that the plant may be shield budded and that it will grow on the Philippine taboc, *Chaetospermum glutinosa.*

**BANAGO**, *Gnetum gnemon.* L. GNETACEAE. (Pl. VI (*a*).)

A large shrub to a tree, attaining a height of 15 meters; leaves opposite, variable in size and shape, up to 10 to 18 centimeters long and 4 to 7 centimeters wide; ovate oblong to lanceolate, smooth and shining. The fruits, growing in small clusters, are sessile, 23 to 25 millimeters long, 13 millimeters across;

from oblong obovoid, compressed toward base, apex blunt pointed; surface smooth, red; seed inclosed in a fleshy covering about 1 millimeter thick; seed coat thin and brittle, about the thickness of paper, separating readily from the seed.

Seventy-four per cent of the dried nut is edible. The seed, or nut, as it is usually called, is eaten boiled or roasted.

According to Dr. Brill, the dried nuts analyze as follows:

| | Per cent. |
|---|---|
| Oil | 1.79 |
| Protein (N × 6.25) | 9.45 |
| Starch | 47.59 |
| Sugar | none |
| Cellulose | 1.03 |
| Other nitrogen-free substances | 4.22 |
| Ash | 1.48 |

The very high starch content in the banago is worthy of notice, and also the remarkable protein content, while it is rather poor in fat. For comparison with other nuts see analysis of the pili, *Canarium ovatum* Engl., in Vol. VIII, No. 2, p. 112, of this REVIEW.

While the banago is fairly well flavored, it is very hard and difficult to macerate, even if roasted or cooked, and in eating qualities it is entirely outclassed by the pili and cubili, *Cubilia blancoi* Bl. Therefore, notwithstanding its nutritive value, the banago is unlikely to become of any importance among Caucasians until some other method can be devised to render it more palatable.

The banago is indigenous to the Philippines, occuring throughout Malaysia, and is also found in Africa, New Guinea and Polynesia. The banago, which ripens in July, is semicultivated in Batangas and some of the Visayas, and is also said to be cultivated in Java.

**BIRIBA,** *Rollinia orthopetala* A. DC. ANNONACEAE. (Pls. III and IV.)

A tree of upright, vigorous growth, attaining a height of 10 meters, with the habit of *Annona reticulata* L.; young growth puberulent; leaves 20 to 29 centimeters long, up to 11 centimeters broad, oblong ovate to narrowly obovate oblong, at first rubescently pilose beneath, later papery and nearly smooth above and hairy with prominent nerves beneath; base rounded or broadly acute, apex acuminate; petioles 9 to 12 millimeters long; flowers solitary, 2 or 3, nodding, opening after 3 p. m., when they emit a strong, pleasant fragrance, proterogynous, undoubtedly entomophilous; peduncle 30 to 48 millimeters long; calyx small, trilobate; corolla gamopetalous, fleshy, 30 to 35 milli-

meters across, dark red inside around the essential organs, with 3 large, rounded, divergent lobes, cream to somewhat greenish yellow in color, 3 small lobes alternating with the large ones, opening of the corolla small, the essential organs similar to those in the Annonas. The fruit is a fleshy, cordiform syncarp, up to 425 grams in weight, and 9 centimeters in diameter in the Philippines; surface between straw and buff yellow; carpels rather irregular, with soft, fleshy projections, usually curved out or upward; areolar lines distinct; skin about 2 millimeters thick; flesh white to grayish and semitranslucent, soft, juicy, quite sweet with a trace of acidity, aromatic, flavor and quality distinct, fair to good; seeds many, about twice the size of a sugarapple seed.

The fruit ripens from July to September and as grown at Lamao is not quite equal in flavor to the sugarapple, but is superior to the custardapple.

There are three separate introductions of the biriba growing at the Lamao experiment station, one of which fruited in 1915, and all of which fruited in 1916 through hand pollination of the flowers. Two of these introductions came from Brazil as *Rollinia orthopetala,* and one has come to hand from Mr. G. Regnard, Mauritius, who sent the seed as *Rollinia speciosa.* Later Mr. Regnard advised the writer that he had sent herbarium material to Kew, England, where the species had been identified as *Rollinia sieberi* A. DC., a synonym of *R. mucosa* Baill.

Barring slight variations of character, such as may be allowed within a species, the plants in the three lots seemed to be so much alike that the blossoming and fruiting were anticipated with a great deal of curiosity, and in 1916 care was taken to pollinate a number of flowers to insure fructification.

The leaves of the plants of Mauritius origin are slightly larger than those of the others, the petioles are shorter, and there are slight variations in the large outer lobes of the flowers in the different lots. The areoles are smaller in the fruits on the plants from Brazil, and the flavor is better, but in all essentials, such as are believed to be specific, the plants from all sources appear to be identical. Provided then that the material has been correctly identified, it would appear that *Rollinia orthopetala, R. mucosa* and *R. sieberi* are the same species.

*Rollinia mucosa* was first described in 1764 as an *Annona,* by Jacquin from Martinique, where it was then cultivated. According to Mr. Regnard, in Mauritius this species is very prolific, the branches of bearing trees often breaking under the

load of fruit, and the fruits are very large, averaging 2.25 kilos in weight, fruits weighing 2.70 kilos not being uncommon.

According to Huber the biriba as described from Brazil was cultivated in that country 250 years ago.

**CHERIMOYA, "GIANT",** *Annona cherimolia* Mill. ANNONACEAE.

A small, spreading, open-headed, semideciduous tree; leaves elliptical oblong to oblong ovate, averaging 19 centimeters in length and 9 centimeters in width, sparsely hairy above, pubescent beneath. The fruit (as grown in the Philippines) has a weight of 500 grams; size medium, 10 centimeters in diameter; shape broadly cordiform, irregular; carpels very prominent, and very variable in size, largely dark green, yellowish green along areolar lines, with more or less red markings; bloom white; areolar lines distinct; skin medium thick; flesh firm, light cream in color, juicy, subacid, sweet, rich, of excellent flavor and quality.

In 1912 the Giant was introduced into the Philippines by the Bureau of Agriculture from Queensland, Australia, and the plants were set out the following year at the Lamao experiment station, where they have been employed to provide scions for propagation and flowers for the hybridization with other Annonas. By means of hand pollination a few fruits, ripening in September, 1916, were obtained from one tree, from which the above description was made.

In Australia the Giant is reported to be a shy and erratic bearer, but the fruit, reliably reported to attain a weight of 1.4 kilograms, is larger than those so far obtained at Lamao. According to Mr. Howard Newport, of the Department of Agriculture of Queensland, the Giant is believed to be a hybrid between the cherimoya and the sugarapple. The comparative vigor the plant has exhibited at sea level in Lamao, the prominent carpels, covered with white bloom, the oblong leaves, and the absence of tomentum on leaves and fruit, seem to argue in favor of this belief. If the supposition of its hybrid origin is correct we have here a fruit that is greatly superior in flavor and quality to the hybrids of similar parentage which have originated at Lamao.[1]

The flesh is firmer, of a richer, creamier color, a trifle more acid and more richly flavored. Altogether the Giant is a very superior fruit which in flavor and quality surpasses all recent introductions that so far have fruited, barring possibly the pineapples.

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[1] For descriptions and plates of these hybrids see this REVIEW, Vol. VIII (1915), No. 3.

A considerable number of budded Giants have already been distributed in the higher altitudes of the Philippines to which the variety may prove better adapted than to the lower regions. A large number of annona hybrids with the Giant as staminate parent are being brought into fruiting at Lamao.

Eighty-four per cent of the cherimoya is edible, analyzing 1.83 per cent protein, 18.41 per cent sugar and a trace of acid.

**DUHAT, "BULACAN,"** *Eugenia jambolana* Lam. MYRTACEAE. (Pl. V (*a*).)

A medium to rather large tree, 8 to 15 meters in height; leaves opposite, 8 to 15 centimeters long and up to 9 centimeters wide, ovate to elliptic or obovate, coriaceous, shining; flowers numerous, yellowish, crowded in terminal or axillary panicles, even below the leaves. The fruit is in loose clusters, 2 to rarely more than 7, averaging 15 millimeters in length; form obovoid; base rounded, apical cavity small; surface smooth, dark purple to black, shining; skin very thin, adhering to pulp; pulp white, tinged with purple, juicy, sweet, subacid and pleasantly flavored, in texture resembling somewhat the cherry; seedless.

According to Pratt and Rosario [1] the sugar content of the duhat is 12.70 per cent, the acidity (as malic) 88 per cent and the protein 0.81 per cent.

The duhat is a native of tropical Asia; it is probably of prehistoric introduction into the Philippines and is common throughout the Archipelago, ripening principally during May and June.

The ordinary duhat is somewhat larger than the Bulacan, up to 25 millimeters long and 20 millimeters across, averaging about 4.5 grams in weight, of which about 60 per cent is edible; the clingstone seed is rather large. The fruit may be eaten out of hand with relish, and it makes an excellent jelly; in India it is sometimes made into wine.

Now and then trees are found in the Philippines with much larger fruits than those ordinarily appearing in the markets, these being sometimes referred to as "carabao" duhats.

In 1916 Mr. Bernabe Malvar, assistant agricultural inspector, discovered a duhat tree in Baliwag, Bulacan, bearing seedless fruits. This variety, the latest addition to the seedless tropical fruits, described above and illustrated in plate V (*a*), has been named "Bulacan" after the province in which it was found, and it is now being propagated at the Lamao experiment station for distribution. With better cultivation and care, this somewhat undersized variety may be expected to yield larger fruits than those illustrated.

[1] Phil. Jour. Sci., Vol. VIII (1913), No. 1, Sec. A, p. 77.

GENIPA, *Genipa americana* L. RUBIACEAE. (Pl. II (*b*).)

A medium-sized tree with a straight, tall trunk and upright habit; leaves opposite, 25 to 35 centimeters long, up to 12 or more centimeters broad, oblanceolate to obovate oblong, sometimes undulate, shining above, dull green beneath, with prominent midrib, glabrous; base and apex acuminate; petioles 10 millimeters long. The fruit is usually solitary, produced below the leaves, large, from 10 to 15 centimeters long, up to 10 centimeters in diameter equatorially, weighing 700 grams; form ellipsoid to obovoid, with a stout stem and rounded base, apex a shallow cavity, sometimes mammilate; surface smooth, russetted, splashed with gray; skin thin, adhering to flesh; pericarp 10 to 20 millimeters thick, fleshy, dirty yellow, tough, but of a pleasant, acid flavor, fairly juicy; the pulp in which the seeds are embedded separates readily from the thick pericarp which it resembles except in being less tough and more juicy; seeds numerous, flat, of about twice the size of an apple seed, clingstone.

The genipa is very aromatic, and the edible part of the fruit both in texture and flavor somewhat resembles dried apples. In Porto Rico it is used in making a cooling drink that is said to be of excellent quality; it may also be made into sherbet and ice cream. The flesh is sometimes eaten. The fruit makes a good jelly, quite similar in color and flavor to apple jelly.

According to Dr. Brill, the genipa analyzes as follows:

| | Per cent. |
|---|---|
| Protein (N × 6.25) | 0.51 |
| Sugar | 4.30 |
| Acid (as malic) | 0.63 |
| Other nitrogen-free substances | 11.21 |
| Insoluble | 3.88 |
| Ash | 0.20 |

The seeds and peel constitute 30 per cent of the fruit, the edible portion being 70 per cent.

According to Dr. Brill the fruit contains large quantities of pectin and should therefore prove a useful addition in the preparation of jellies from fruits deficient in pectin, such as the roselle.

The genipa is of West Indian origin and is rare outside of its native habitat. It was introduced into the Philippines several years ago by the late Mr. W. S. Lyon, and fruited at Lamao for the first time in 1913.

GUISARO, *Psidium molle* Bertol. MYRTACEAE.

A shrub of vigorous growth, 2, sometimes exceeding 3 meters in height, young growth quadrangulate, tomentose; leaves op-

posite, 8 to 13 centimeters long, up to 75 centimeters wide, broadly elliptical ovate to obovate, coriaceous, pubescent to tomentose above, tomentose beneath, prominently veined; base rounded, apex apiculate; petioles 7 millimeters long; flowers axillary, solitary up to three, white, fragrant; peduncle 3 centimeters long. The fruit is roundish to oblate, 25 to 30 millimeters in equatorial diameter, more or less ridged longitudinally; stem inserted in a shallow cavity; calyx persistent, with a shallow apical cavity; surface yellowish green, covered with fine brownish hairs which easily rub off on handling leaving a smooth surface; skin thin; flesh greenish yellow, somewhat grainy, juicy, subacid, of pleasant flavor and aroma, in these respects strongly resembling the guava; seeds comparatively few, small.

The guisaro, ripening principally from May to October, because of its small size is inferior to the guava, which, however, it surpasses in aroma and flavor and it may be used the same as the guava. From a commercial point of view it is therefore valueless, but it might be crossed to advantage with the guava and other related species.

The guisaro is indigenous to Mexico and Central America and is but rarely seen outside of its native habitat. The species was introduced into the Philippines by the Bureau of Agriculture in 1912 and fruited for the first time at the Lamao experiment station in 1916.

The guisaro is readily propagated by shield budding.[1]

**HEVI**, *Spondias cytherea* Sonn. ANACARDIACEAE. (Pl. II (*c*).)

A medium-sized deciduous or semideciduous tree of rapid growth, and rather soft, brittle wood; leaves pinnate, up to 70 centimeters long and 27 centimeters broad, leaflets in 12 to 13 pairs, elliptical oblong, acuminate, serrate, somewhat fleshy, aromatic; flowers greenish, small and inconspicuous in terminal panicles. The fruits, frequently 6 to 10 in a loose cluster, on long slender stems, are 60 to 75 millimeters long, 50 to 60 millimeters across, with an average weight of 150 grams, occasional fruits weighing 220 grams, form roundish oblong to short obovoid, frequently obscurely 5-angled; surface smooth, golden brown in color, with small, corky lenticels; skin thin but fairly tough; flesh pale yellowish, the texture somewhat resembling that of the peach but firmer, containing a few coarse fibers, quite acid near

[1] For detailed instructions in vegetative methods of propagation of the guisaro and most of the other species discussed in this paper see Bulletin No. 32, of this Bureau, and the "Current Notes" in previous issues of this REVIEW, Vols. VIII and IX.

the skin, the interior very sweet and rich, quite juicy and very aromatic, flavor and quality very good; stone comparatively small, but with many coarse fibers extending into the flesh.

Season of ripening October, November, and December.

According to Mr. H. C. Gore, Bureau of Chemistry, United States Department of Agriculture, the edible portion of hevis grown in Florida gave the following analysis:

| | Per cent. |
|---|---|
| Soluble solids | 18.40 |
| Insoluble solids | 5.35 |
| Acids (as malic) | 0.60 |
| Starch | 3.97 |
| Reducing sugar as invert | 8.38 |
| Protein (N $\times$ 6.25) | 0.54 |
| Ash | 0.50 |

The edible portion constitutes 65 per cent of the total weight of the fruit.

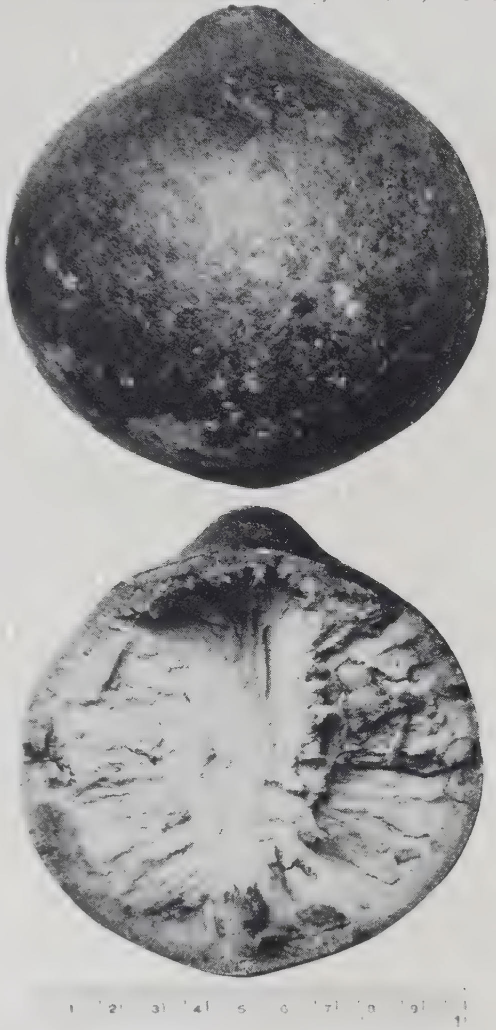
The hevi is quite variable, some trees bearing small fruits of but little value while others produce very excellent ones. Pomologically the hevi is greatly superior to all other species in the genus and a valuable addition to the Philippine fruits.

Nearly 100 seedlings were set out in 1913 and 1914 at Lamao for observation and selection at the same time that experimentation with budding was begun, the results of which have previously been published in this REVIEW. Experiments in propagation from cuttings have also been made. Cuttings from well-matured wood and rather coarse branches grow now and then but this method of propagation cannot be recommended for general use.

The hevi is indigenous to Polynesia but has become quite widely distributed throughout the Tropics. Recently introduced into the Philippines the hevi fruited for the first time at the Lamao experiment station in 1915 and several trees fruited in 1916. Hevi is the first published vernacular name of *Spondias cytherea*, first named and described by Sonnerat in 1762.

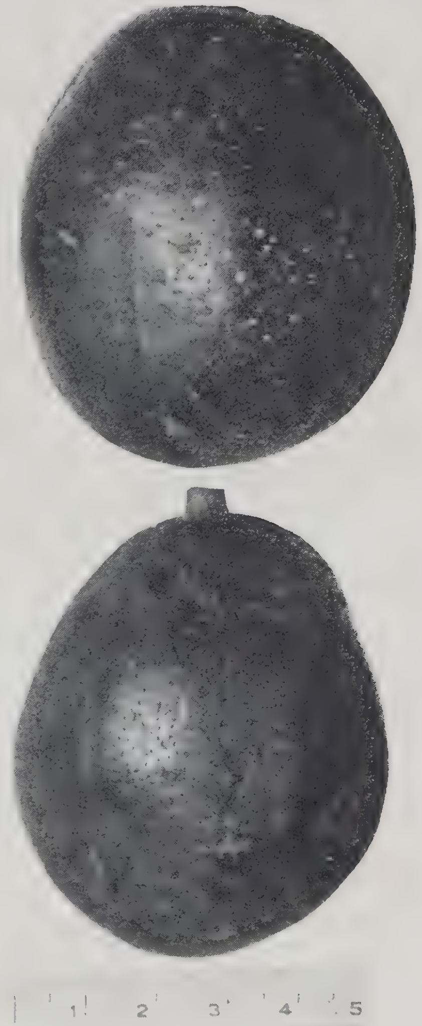
**HONDAPARA**, *Dillenia indica* L. DILLENIACEAE. (Pl. VII (*a*).)

A handsome, medium-sized tree with compact round-headed crown, young growth hairy; leaves 30 to rarely exceeding 43 centimeters in length and 9 centimeters in width, oblanceolate, coarsely serrate, dark green, with prominent veins; petioles 4 to 6 centimeters long; flowers terminal, large, white, attractive and fragrant. The fruits are large, 80 to 85 millimeters long, 90 to 105 millimeters across, from 530 to 800 grams in weight; form oblately cordiform, irregular, three prominent shoulders



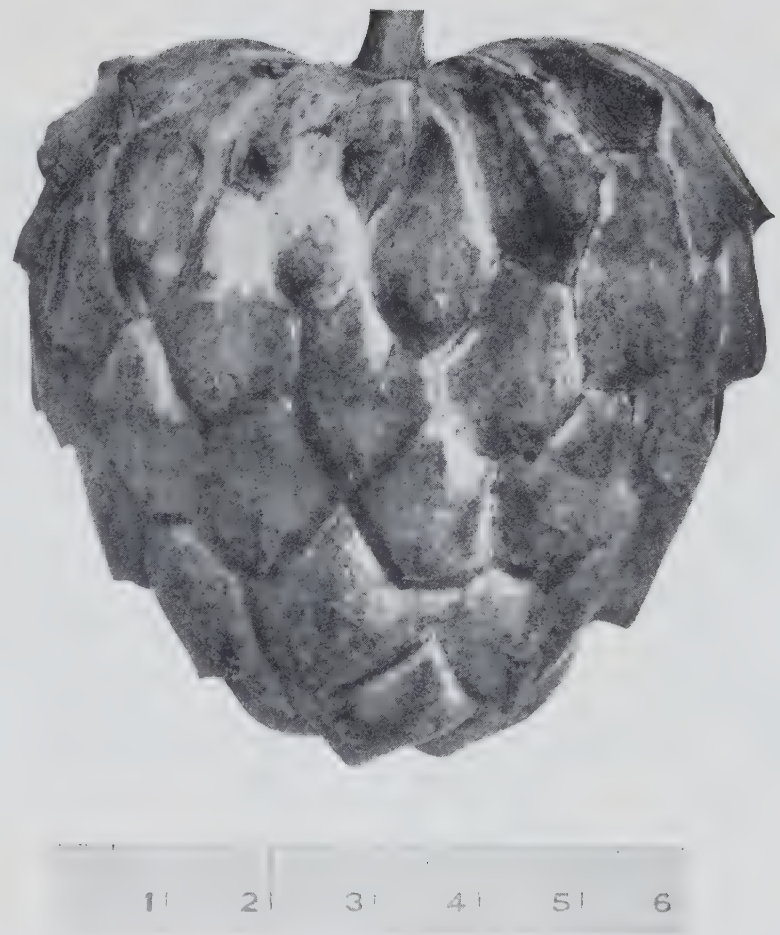
(a) Bael, *Aegle marmelos.*

(b) Genipa, *Genipa americana.*



(c) Hevi, *Spondias cytherea.*

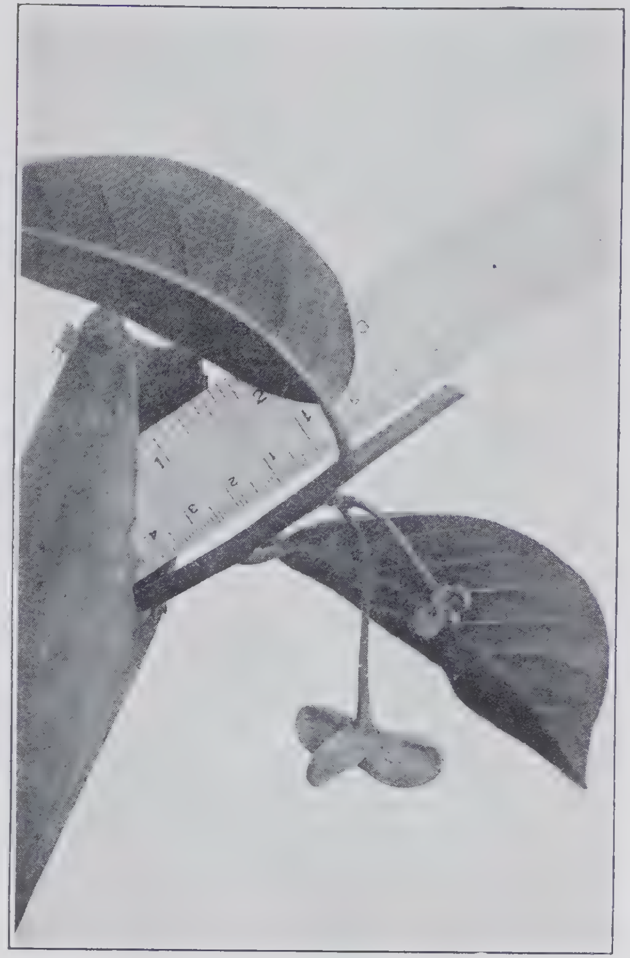

(*a*) Biriba (No. 1) *Rollinia orthopetala*, of Brazilian origin.




(*b*) *Rollinia mucosa* from Mauritius, believed to be a variety of the biriba.

(*a*) Flowering twig of biriba (No. 1), *Rollinia orthopetala* of Brazilian origin.

(*b*) Flowering twig of biribia (No. 2), *Rollinia orthopetala*, of Brazilian origin.



(*c*) Flowering twig of *Rollinia mucosa* from Mauritius.

PLATE V.


(*a*) "Bulacan," the seedless duhat, *Eugenia jambolana*.

(*b*) Ketembilla, *Aberia gardnerii*.

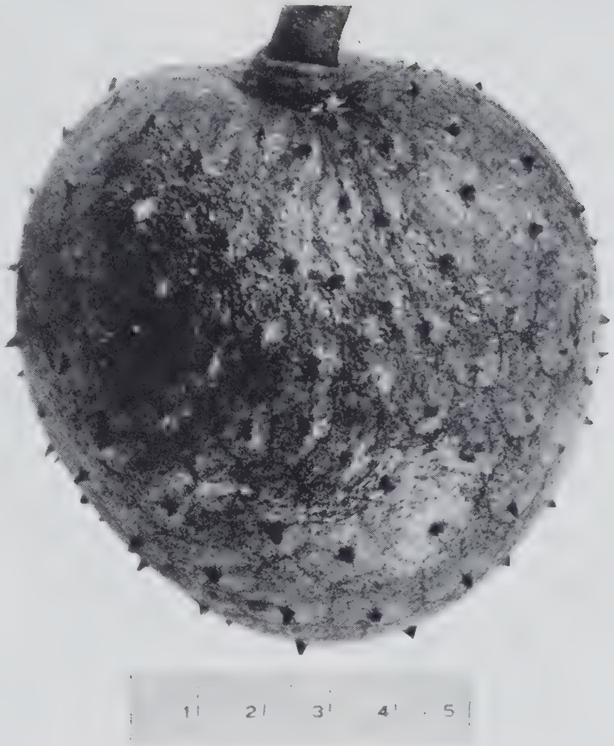

(*c*) Pereskia, *Pereskia aculeata*.

(*a*) Banago, *Gnetum gnemon*, fresh and dried.

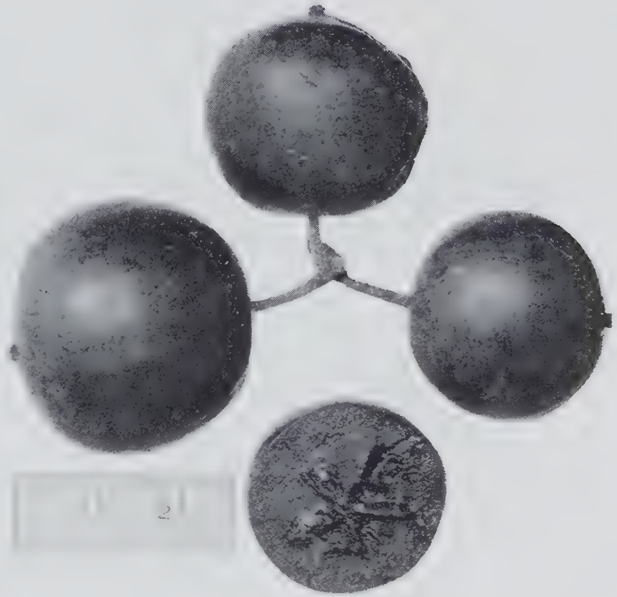
(*b*) Litoco, *Calamus* sp., section of fruiting raceme, "shell," the "shelled" fruit seen from apex and side, two sections and seed.

(*c*) Fruiting raceme of the litoco, *Calamus* sp.

(a) Hondapara, *Dillenia indica.*



(b) Maron, *Annona montana.*



(c) Paniala, *Flacourtia cataphracta.*

"Siam," the Siamese seedless pomelo, *Citrus decumana*.

PLATE IX.

(*a*) Yaruma, *Cecropia palmata*.

(*b*) Fruiting yaruma tree about 22 months old. Lamao experiment station.

Modified form of native coconut-meat grinder, in which the weight and bearing surfaces are of concrete.

at the base, with a cavity in center, where is inserted the long, comparatively slender stem; apex broadly rounded; surface smooth, greenish, with small, pale-green lenticels; sepals persistent, large, fleshy and fibrous, inclosing the carpels, containing the small seeds about the size of those of a guava.

In contrast to the fruits of the edible-fruited Dillenias in the Philippines, previously described and illustrated in this REVIEW, of which the fleshy carpels are considered the edible portion of the fruit, the edible part of the hondapara consists of the thick, fleshy sepals, which are acid and of the flavor of an unripe apple. In India the sepals are employed in making a jelly and cooling drinks, and are also used as a vegetable in curries.

In size, the hondapara greatly exceeds the catmon, *Dillenia philippinensis* Rolfe, and palali, *D. reifferscheidia* F. Vill., but these two Philippine fruits surpass the hondapara in edible qualities.

The hondapara is a native of India and Ceylon. It is an admirable ornamental shade tree. The fruits, produced in great profusion, mature in September and October. There are a number of fair-sized hondapara trees in Manila, and the species was probably introduced coincidently with or shortly after the American occupation of the Philippines.

**KETEMBILLA**, *Aberia gardnerii* Clos. BIXACEAE. (Pl. V (*b*).)

A large shrub rather than a tree, spiny when young, the branches on the mature plants being slender and spineless; foliage bright green; leaves ovate to narrowly ovate oblong, quite commonly oblique, sometimes curled, up to 11.5 centimeters long, and 5.5 centimeters broad, sparsely serrate, velvety beneath; base rounded to acute or acuminate; apex acuminate, the large veins reddish beneath; petioles 1 centimeter long; flowers axillary, rarely more than one, small and greenish. The fruit is pendent, 20 to 23 millimeters in diameter, weight 5 to 9 grams; form usually spherical, sometimes oblate; surface velvety, golden brown to almost black on sun-exposed side; lenticels small, light green; skin thin, quite similar to that of the peach, peeling readily from the flesh; the flesh next to skin in color and texture resembles the peach, the red stained, inner portion surrounding the seed being semitranslucent; acidity pronounced; flavor and aroma pleasant and distinct; seeds usually 3, about the size of apple seeds.

The fruit is too acid for eating out of hand, but is excellent for preserving, and in the strains introduced may be considered as one of the most promising of the small-fruited recent plant immigrants that so far have fruited at Lamao.

The ketembilla is a native of Ceylon and of recent introduction. It fruited at the Lamao experiment station for the first time in 1916, and bears two annual crops of fruit, one in March and April with occasional fruits during the summer months, and a second crop in October and November.

LITOCO. *Calamus* sp. PALMAE. (Pl. VI (*b*).)

A climbing, spiny rattan with a coarse stem attaining a height of 10 meters or more, and large leaves. The fruits are borne on branching, arching racemes, 15 to sometimes exceeding 30 on a branch, sessile; size large, 20 to rarely exceeding 25 millimeters in diameter, averaging 7 grams in weight; form globose, with a bony, black projection at apex; skin a series of quadrangular thin scales, slightly overlapping, glossy, straw-white, with brown margins; flesh divided into 3 segments, separating perfectly from each other and the skin, light brown, resembling somewhat in texture that of the cherry, juicy, subacid, with a sprightly, tart, pleasant, distinct flavor recalling to some extent the lanzon, a trifle astringent; seeds rarely more than one, frequently absent, about 11 millimeters long, freestone, brownish.

The fruit is very ornamental and striking, and the brittle skin peels off from the flesh very much like the shell of a hard-boiled egg. It ripens in October and November, and is of good keeping qualities, fruit having been mailed to the writer from Kiangan that remained in good condition for two weeks from the date of shipment. While in Kiangan the fruit is eaten quite extensively when in season, it is perhaps a little too tart for eating out of hand, at least until one becomes accustomed to it. It would unquestionably make a superior preserve like its relative, the calapi, *Calamus ornatus* var. *philippinensis* Becc., from the Visayas. Altogether the litoco ranks as one of the best small, native fruits in the Philippines, and some day is likely to become of considerable prominence.

The litoco, as yet an undetermined, unnamed species, occurs in Kiangan, Ifugao, Mountain Province, at an elevation of about 700 meters, where it was found by the writer in May, 1916, and has also been collected in Dupax, Nueva Vizcaya.

MALPI, *Malpighia glabra* L. MALPIGHIACEAE.

A straggling, unattractive, glabrous shrub, about 3 meters high; leaves opposite, almost sessile, elliptical oblong, small, up to 7 centimeters long and 3 centimeters wide, glabrous; base rounded, apex rounded to acute; flowers axillary, 2 or more, pale red, about 18 millimeters across. The fruit is 20 to 22 millimeters in diameter, shorter than broad; average weight 3.8

grams; stem slender, inserted into a comparatively large basal cavity; apex a deep narrow cleft; surface smooth, bright red; skin very thin; flesh scant, yellowish, juicy to almost watery, subacid, rather poorly flavored; seed rather large.

The fruit has too little flavor to be eaten with relish out of hand but makes a very good jelly. Until more superior varieties shall have been originated the malpi will rank as one of the less important, small, tropical fruits.

According to Mr. Gore, the pulp of malpis grown in Florida analyzed as follows:

| | Per cent. |
|---|---|
| Soluble solids | 6.77 |
| Insoluble solids | 1.13 |
| Acid (as malic) | 1.39 |
| Total sugar as invert | 2.44 |
| Nitrogen | 0.21 |
| Ash | 0.62 |

The malpi is indigenous to the West Indies, and was introduced into the Philippines in 1912, fruiting for the first time at the Lamao experiment station in 1916.

**MARON**, *Annona montana* Macf. ANNONACEAE. (Pl. VII (*b*).)

A small, semideciduous tree rarely exceeding a height of 10 meters; leaves average 15 centimeters in length and 6 centimeters in width, obovate oblong, coriaceous, glabrous, dark green and shining above, malodorous when bruised; base acute or rounded, apex abruptly acuminate; petioles 6 millimeters long; flowers one or two, large, orange yellow, rather similar in structure to those of *A. muricata* except in having much larger inner petals entirely covering the essential organs, proterogynous and evidently entomophilous, nocturnal. The fruit is subrotund to cordiform, averaging 8 centimeters in diameter; surface yellowish green, smooth, with short, sparse carpellary spines; carpels not raised; areolar lines rather indistinct; pulp yellowish, juicy, subacid, but very fibrous, somewhat similar in flavor and texture to the guanábano but greatly inferior to that fruit, and barely edible; seeds numerous, rather large, pale brown.

The maron is a native of the West Indies and the northern part of South America.

Two introductions of the maron, one from Porto Rico and one from Mauritius, have fruited at Lamao, the first in 1915, with but slight varietal differences. At present, the maron is of practically no value as a fruit, but it may be useful for hybridization with related species and as a stock, for which purpose it is now being grown at Lamao.

**PANIALA**, *Flacourtia cataphracta* Roxb. FLACOURTIACEAE. (Pl. VII (*c*).)

A large shrub to a small, handsome tree, of compact habit, 7 meters or more in height, the trunk and larger branches spiny; leaves alternate, up to 13 centimeters long, rarely exceeding 5.5 centimeters in width, ovate to ovate oblong; crenate, acuminate, dark green and shining; petioles 7 millimeters long; flowers small and inconspicuous in loose axillary, few-flowered cymes. The fruits are solitary, or in a loose cluster up to six, rarely more than 20 millimeters long; form roundish to oblate; base variable from broadly rounded to a shallow cavity; stem slender; apex usually flattened with a small projection at the stigmatic area; surface smooth, dull purple; skin very thin, adhering closely to flesh; flesh firm, brownish green, quite acid, with a trace of sugar, fairly juicy, of agreeable flavor; seeds several, small, about the size of guava seed.

The paniala, ripening in July and August, is of little or no value in the fresh state, but it makes a good marmalade and would undoubtedly make a good jelly.

A native of India and adjacent countries to the East, the earliest introduction of the paniala was made about 1905 by the late Mr. W. S. Lyon, the plant being set out at the Lamao experiment station where it has made excellent growth and fruited sparingly every year beginning with 1914.

Judging from the limited experience with the paniala at Lamao the species is at present of minor pomological value. The plant makes a very good ornamental and apparently could be used to good advantage as a "live fence" and a wind break.

**PERESKIA**, *Pereskia aculeata* Mill. CACTACEAE. (Pl. V (*c*).)

A climbing, spiny vine of vigorous growth; leaves up to 8 centimeters long, sometimes exceeding 3 centimeters in width, oblong ovate, fleshy; base acute, apex acuminate; flowers attractive, profuse, paniculate, pale yellow, fragrant, about 35 millimeters across. The fruits are borne in terminal loose clusters of 4 to rarely exceeding 20; individual fruits 15 to 20 millimeters in diameter; form roundish; apex a shallow cavity; surface a dull, brownish yellow, smooth, with 10 to 12 fleshy, leaf-like bracts including those crowning the apex; skin very thin, tough; flesh pale orange, juicy, mildly acid, suggesting the tomato in flavor and aroma; seeds 2 to 5, small.

The pereskia is a native of the American Tropics and was introduced from Florida in 1912, and fruited for the first time at Lamao in 1915. The plant may be grown as an ornamental, trained over an arbor or on the side of the house, and produces

flowers and fruit abundantly during a large part of the year. The fruit is too insipid to eat out of hand, but boiled in sugar is said to make a good preserve similar to that of the gooseberry.

**PITANGA** *Eugenia uniflora* L. MYRTACEAE.

An arborescent shrub or small tree of compact habit, rarely exceeding 6 meters in height, young growth reddish; leaves opposite, nearly sessile, ovate, glabrous, dark green above, paler beneath; apex shortly acuminate, base rounded to subcordate; flowers axillary, solitary, white and fragrant. The fruit is 2 to 3 centimeters in diameter, weighing 4 grams; form subglobose, with 8 prominent longitudinal ribs, the slender stem inserted in a shallow cavity; apex crowned by the persistent calyx; surface smooth, dark crimson to almost black, shining; skin thin; flesh crimson, soft, very juicy, subacid and of good flavor, resinous when not quite mature; seeds one or two, rather variable in size.

When fully ripe the fruit of the pitanga is excellent eaten fresh, and it makes a good jelly. According to Popenoe, in Brazil it is used in making a delicious sherbet.

An analysis made of Florida-grown pitangas by Mr. Gore gave the following results:

| | Per cent. |
|---|---|
| Soluble solids | 11.32 |
| Insoluble solids | 2.31 |
| Acid (as malic) | 1.32 |
| Total sugar | 8.11 |
| Nitrogen | 0.16 |

Ninety per cent of the fruit is edible.

The pitanga is indigenous to Brazil where it is common in cultivation, but it is now quite widely distributed throughout the Tropics though not extensively cultivated.

The earliest introduction of the pitanga into the Philippines was made about 1903 by the late Mr. W. S. Lyon, and the plants were first seen in fruit by the writer at the Lamao experiment station in April, 1911.

The pitanga is known in various countries as Brazil cherry, Surinam cherry, and French cherry and was first described in 1648 by Piso and Marcgrav under the name Ibipitanga.

**POMELO, "SIAM"**, *Citrus decumana* Murr. RUTACEAE. (Pl. VIII.)

A small tree with rather short, weak spines; young growth pubescent, the pubescence persistent even on the mature twigs and on the midribs beneath, the leaf blades nearly smooth; leaves somewhat reflexed, up to 17 centimeters long, 8.5 centimeters wide, ovate to elliptical ovate, dark green, emarginate, crenate,

the margins turned downwards; petioles 4.5 to 5 centimeters long, with variable wings, up to 38 millimeters wide; flowers in clusters of several, sweet-scented; pedicels 18 to 20 millimeters long; corolla 50 millimeters across; petals 4, reflexed; stamens 28 to 30 with abundant pollen; ovary obovoid, large, 10 millimeters long, pubescent; style 8 millimeters long; stigma large. The fruit is large, 18 centimeters long, 14.5 centimeters in equatorial diameter; form roundish to short pyriform, compressed toward base, apex a wide, shallow concavity; surface smooth; color greenish yellow; oil cells rather large, conspicuous; skin 2 centimeters thick; locules 15, generally split in the center of the fruit; flesh coarse grained, grayish, tinged with red, very juicy, mildly subacid, quite aromatic, of distinct and good flavor and quality; seedless.

There can be no question but that the Siamese seedless pomelo is a great addition to the citrus fruits and a fruit of distinction among the world's seedless fruits. The drawback is the excessively thick rind, but considering that the first crop from young citrus trees is usually thick skinned, it seems probable that the normal Siam will have a thinner skin than the one described and illustrated.

Budwood of the above variety, which has been named "Siam" in honor of the country of its origin, was procured by Mr. H. H. Boyle, then assistant horticulturist of this Bureau, in 1913 from a tree growing in the garden of Prince Yugelar, Bangkok, Siam, during a visit made by Mr. Boyle to that country. The scions were propagated and the resulting trees planted in the citrus orchard at the Lamao experiment station under P. I. No. 3389. The fruit described above and illustrated on plate VIII is, so far as the writer is aware, the first of the Siamese seedless pomelos to fruit outside of Siam.

It may be of interest to know that the tree bearing this first fruit grew on calamondin stock, and did not exceed 1 meter in height at the time of fruiting, October, 1916.

**YARUMA**, *Cecropia palmata* Willd. MORACEAE. (Pl. IX.)

A small dioecious tree, attaining a height of 10 meters or more, of luxuriant growth and brittle wood; leaves 25 to exceeding 50 centimeters in diameter, palmately 9 to 11 lobate, dark green above, silvery white beneath; petioles 25 to 45 centimeters long; the flowers, borne in 2 to 5 catkins on a peduncle, on the pistillate trees develop into long slender, grayish to greenish fruits, 15 to 25 centimeters long, and 15 to 18 millimeters in diameter; flesh greenish, very juicy to rather watery, sweet, aromatic, and of good flavor, inseparable from the minute innumerable seeds.

The yaruma is indigenous to tropical America, and apparently was known by some of the early travelers and botanists such as Oviedo, Piso, and Marcgrav. Botanically, the fruit, which ripens throughout the greater part of the year, is an everted and elongated fig and in its eating qualities somewhat resembles a fresh fig but is more watery. Owing to the uneven ripening of the fruit, which may be over-ripe at the apex and immature toward the base, and the fondness for it by ants, flies, and other insects, the fruit is of very little value, and must be carefully watched and picked when "just right" in order to be palatable. The fruit may then be eaten raw; boiled in sugar it makes a good preserve.

The yaruma was introduced in 1911 and fruited at Lamao for the first time in 1913.

Experiments carried out at Lamao indicate that long cuttings, made from stout, well-matured wood, may be rooted, but the number of successful cuttings is small.

# HISTORICAL REVIEW OF THE ONCE IMPORTANT INDIGO INDUSTRY OF THE PHILIPPINE ISLANDS.

By E. D. DORYLAND, *Agricultural Inspector.*

There are a variety of common names for the commercially few of the nearly three hundred all tropical species of the *Indigofera*—a genus of the *Leguminosae,* so called because of the ability of some of its members to produce a glucoside indican from which indigo is extracted by a mechanical, solvent process. The old Sanskrit name for indigo, *Indigofera tinctoria,* until recently the principal commercial dye producer, is nili, or nila, while the old Latin name for the same plant is indicum, thus showing that as far back as Roman times it was recognized that indigo came from India, and was probably indigenous to that place. Doubtless, it was from India or some other neighboring country that the plant was first introduced into the Philippines.

The common names employed throughout the Philippines other than the English form "indigo," are anil, añil, and tayom, or a similar name. Tayom is the name used on the Island of Luzon by the Tagalog, Ilocano, and Pangasinan peoples, and it is in the rise and fall of the industry among these people with which we are principally concerned.

Indigo, at one time a great commodity of tropical export, has in recent years yielded its once superlative position as a colorer of fabrics, to a product born of science, and has gradually given way before the inroads of the anilin dyes of commerce, which became particularly aggressive about 1880. The creation of this benzol-anilin industry has delivered a lingering deathblow to an agricultural enterprise that was once a flourishing industry throughout Southern and Central Asia, Malaya, South and Central America, and to a limited extent in practically all other tropical, and some semitropical countries.

Only recently, since its most favored days, has the price of the vegetable indigo been such that it could be produced on

a remunerative basis under Philippine conditions. This recent high price was brought about by the German dyestuffs being cut off from their old markets, and the vegetable dyes were used instead. Thus through the influence of the European war has indigo again become a source of profit. This recent boom is perhaps the last struggle for life of an industry that can only be made profitable where pitifully small wages are paid for labor.

This recent show of life of the vegetable indigo industry is perhaps the last, because the civilized nations of the world have received a severe lesson by having German dyestuffs shut off from them by the British blockade, and are now developing their own coal-tar dye products, so that in the event of another world catastrophe, these countries will not be dependent upon the vegetable product. It is with this idea of the nearing end of the once important vegetable indigo industry that this brief historical review of the Philippine process is here related.

During the early days of the vegetable indigo industry in the Philippines, the process of extracting the indigo from the plant was primitively crude, and was somewhat as follows: Planting was done during the latter part of the rainy season, and if the ravages by locust left sufficient foliage the plants were cut in May or June of the next year; after cutting they were placed in casks filled with water, then steeped; after steeping for several hours, usually 10 to 16, the plants were removed and a certain quantity of lime was mixed with the water for flocculating purposes; the solution was then poured into other casks where it remained until the coloring matter had completely precipitated; as soon as this had taken place the water was drawn off and the indigo left to dry after which it was cut into small pieces ready for the market or for home use.

As imperfect as this method of manufacture was the indigo brought a good market price and paid an excellent profit, sometimes as high as 90 per cent. This, however, was back in the days when 60 per cent of the people of Narvacan, and Santa Catalina, Ilocos Sur, were engaged in home dyeing, and before the anilin dye of commerce penetrated to the furthest markets of the globe.

The Philippine indigo plant is rich in indigotine, but the crude process of manufacture of the dye made it rank second in quality to the indigo from other sources.

The market price in 1914 before the war began was ₱30 per quintal, while its maximum price years ago was ₱100 to

₱120, but this was during the "bonanza" years from 1864 to 1875, when the exports ranged from 98 to 158 tons per annum, respectively.

In recent years a company of Chinese started a dyeing establishment in Vigan, Ilocos Sur, in which imported dyes were used, and this was the beginning of the end, commercially, of the indigo industry of the Luzon Provinces, revived only by the recent strife in Europe, and doomed to certain failure again after the war. To attempt to revive this industry so as to compete with modern science would be like trying to reverse the hands of time, plainly an impossible task. However, the old concrete steeping vats and wells will remain, then as now, as landmarks of practically an extinct industry, that has helped to lay the foundation of many a fortune.

# LOCAL PROCESSES OF COCONUT-OIL EXTRACTION IN THE PHILIPPINES.

By C. ATWOOD GARDINER, *Assistant Agricultural Inspector.*

The valuation of the coconut as an important economic cannot be overestimated, since it furnishes not only valuable oils and tallows but several very wholesome human foods as well.

The market for coconut oil is consequently practically unlimited. Among the principal markets for this product the cities of Marseille and Barcelona rank first, the former being known as the City of Oils, while the United States furnishes a market which bids fair to rival these. The following table shows the number of tons of copra exported from the Philippines during the year 1915:

| | Tons. |
|---|---|
| Continent (Marseille and Barcelona) | 88,021 |
| United States | 30,427 |
| United Kingdom | 11,640 |
| Japan | 1,470 |
| Total | 131,558 |

There are approximately 30 million bearing and 24 million immature coconut trees in the Philippine Islands. The fruit of these trees is variously converted, a part directly into oil and still more into copra.

At the present time there are two large and a number of small modern centrals in the Islands engaged in the manufacture of coconut oil for export. These centrals have been gradually increasing their capacity and during the fiscal year ending June 30, 1916, 14,592,899 liters of oil were exported, valued at $2,988,161.

In addition to the oil extracted by these modern centrals a large quantity is produced by small mills throughout the coconut regions, and this oil, amounting in the year ending June 30, 1916, to 2,688,305 liters, valued at $356,644, was used to supply the home market. The small mills are owned and operated by the individual farmer, with the assistance of his family, or occasionally one or two helpers. The mills are entirely the product of home manufacture and are very crude, but,

notwithstanding their crudity, 60 per cent of the oil can be extracted by this process. A brief description of the machines and the methods employed in these small mills follows:

The mill consists primarily of a building, usually about 6 by 9 meters, without floor, though in some instances larger and more elaborate structures are used. Often these mills are nothing more than a lean-to against the side of the owner's residence.

The machinery includes, first, the "tapasan" for husking (fig. 1). The husker is very simple, consisting merely of a plow-point or similarly shaped piece of steel fastened to a tripod. The operator stands over the husker, takes the nut in both hands and with a downward rotary motion strikes it upon the

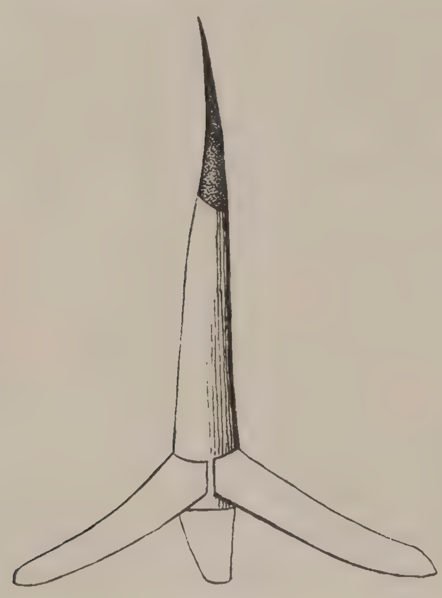


FIG. 1. Tapasan.

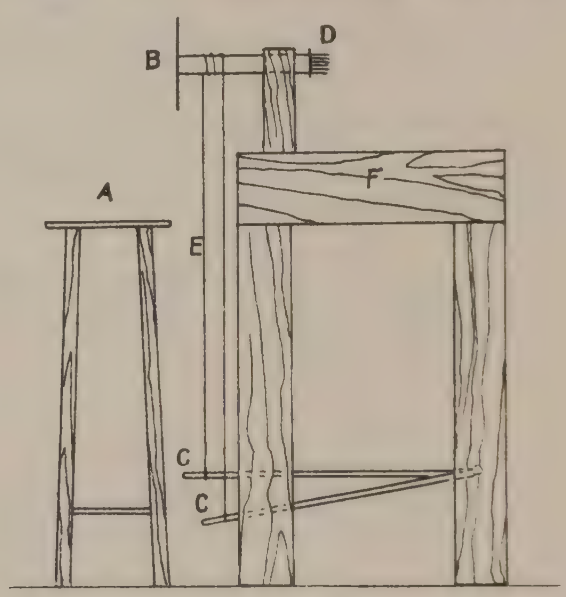



FIG. 2. Kabiawan.

point, turning back and tearing loose a portion of the husk. This process is repeated, turning the nut around at each stroke, until the husk has been removed. One man can husk by this method from 1,000 to 1,500 nuts in a working day of 10 hours.

After husking, the nut is cut in half by holding it in the left hand and striking it with a bolo, or cutlass. Some mills save the water from the nut and feed it to cattle; it is said to be quite fattening.

The "kabiawan," for extracting the meat, comes next, and this machine is by far the most ingenious of all (fig. 2). It consists of a kind of brush, made up of number of stiff steel points. This brush is revolved, or rather turned first clockwise and then counter clockwise, by means of a rope, E, which is wound around the shaft and connected with two pedals operated by

the feet. The operator sits on the stool, A, and presses his breast against B, which is a round plate on a pin fastened to the end of the shaft. With his feet upon the pedals, C, he sets the brush in motion, presses a half nut against it, and the meat is dug out by the steel points and drops into the box, F, or in some instances to the floor. One man can remove the meat from about 1,000 nuts per day.

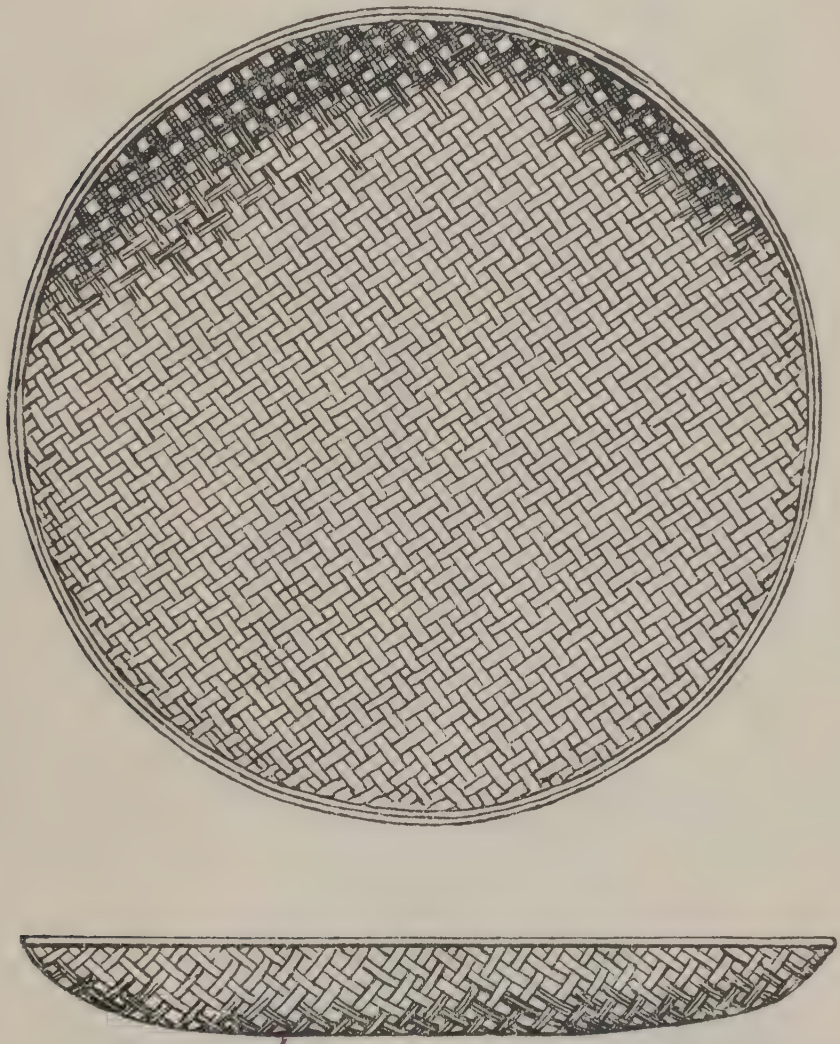


FIG. 3. Bithay.

After being extracted the meat is passed through a bamboo sieve called "bithay" (fig. 3). This is a loosely woven flat basket through which the fine particles will pass.

The larger particles which remain in the bithay are then ground in the "ilohan." The ilohan is made up of a wooden roller on a plank (fig. 4). The roller is weighted by means of stones tied around its center, as shown. The roller is provided with handles at each end and the operator standing at one end works the roller back and forth with the left hand while

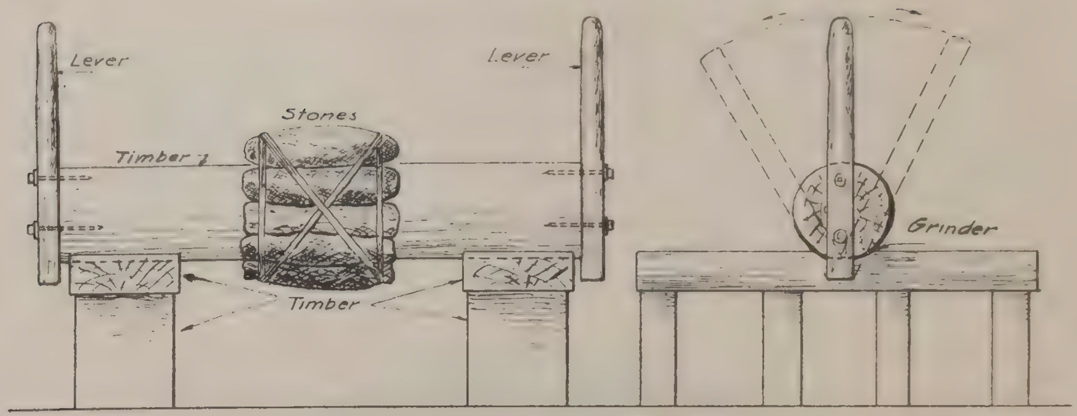



FIG. 4. Ilohan.

feeding the meat in under the roller with the right. When ground, the meat drops to the floor.

A more elaborate form of this grinder is one in which the roller is weighted with concrete, the bearing surfaces being reënforced, both on the roller and the stand, with the same material. (Pl. X.)

After grinding and sifting, the meat is assembled and boiled in the "kawas," or large metal bowls (fig. 5). The husks and shells of the nuts serve as fuel.

The meat is taken from the kawas and placed in bamboo baskets, called "andulan," which are then inserted in the press, or "hapitan" (fig. 6). This consists of two heavy planks loosely fastened together by a pin at one end and a wooden screw at the other. Here the oil is extracted by tightening the screw, and drops into the "banka," or wooden bowl, below the press.

After this first pressing the cake is reground in the ilohan, breaking it up and putting it through the same process as

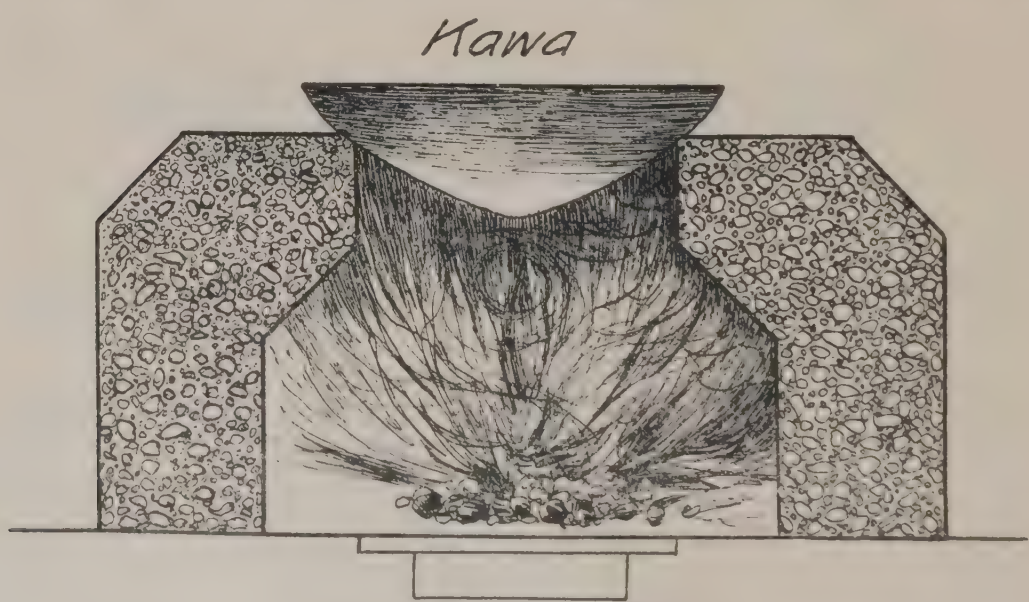



FIG. 5. Boiling process. Section.

with the larger particles of meat. Having been reground and repressed, the residue is thrown away.

The oil is then placed in ordinary coal-oil cans and transported by pack pony or otherwise to the buyers who barrel and ship to Manila.

The output of these crude mills is necessarily small and the labor involved is considerable, yet there are many of these

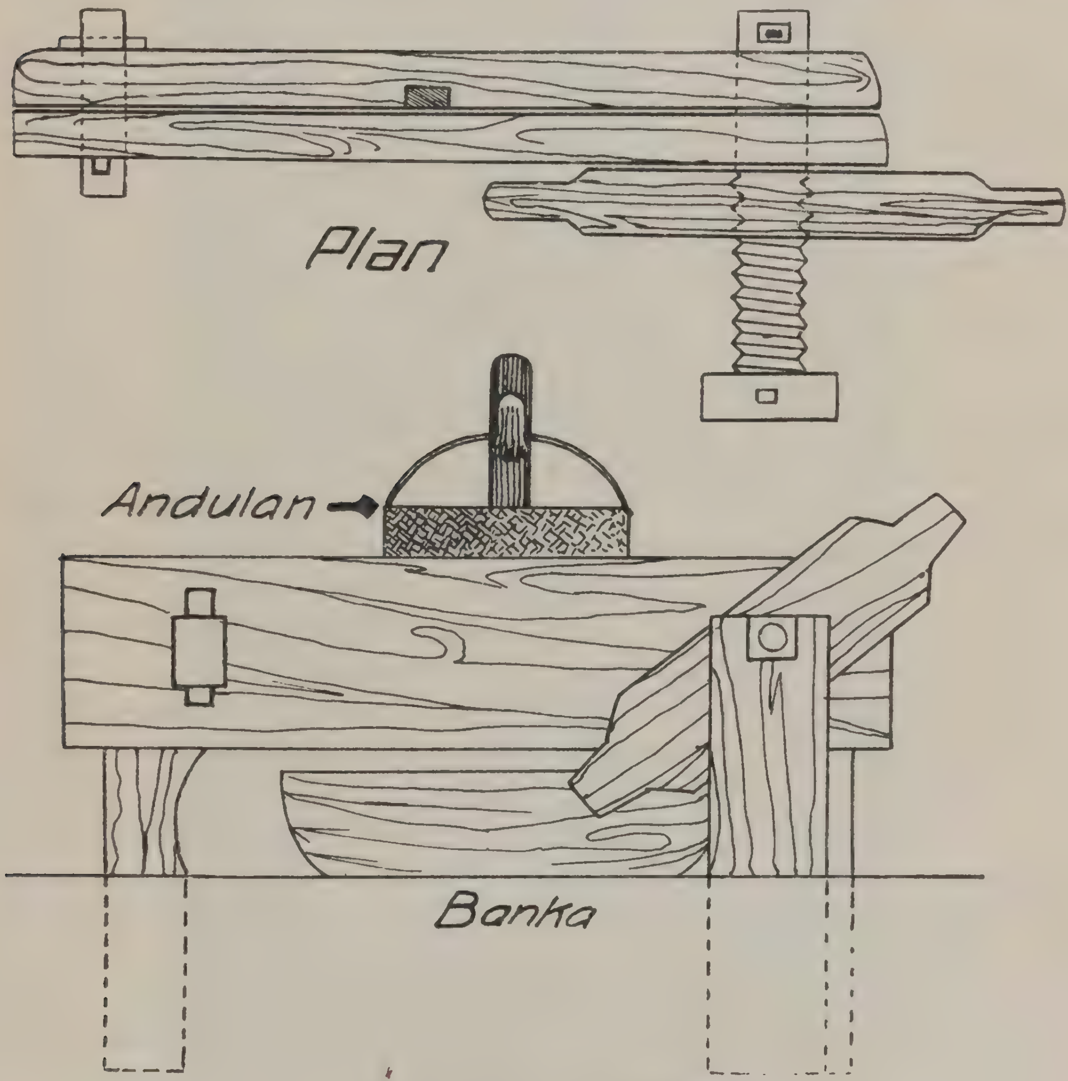



FIG. 6. Hapitan. Side elevation.

factories throughout the coconut regions. The amount produced varies of course with the number of machines employed, but with two presses, one grinder and two meat extractors, including the work of husking and opening, three men will extract the oil from 2,000 nuts in a week.

The method described will give about 113 liters of oil per 1,000 nuts, or a weekly output of 226 liters, which can be marketed, at present prices (January, 1917), at $0.21 per liter or about $48 for the weekly output.

## SEEDLING CANE.

By C. W. Hines, *Sugar Technologist.*

The importance of increasing the yield of sugar was realized long before it was discovered that the seed of the sugar cane was quite often fertile and that distinct varieties might be produced from this seed. Previous to this discovery it was thought that the improvement of the sugar cane could only be brought about by one of the two methods, either through chemical selection of the varieties then cultivated, or new varieties through bud variations. Accordingly extensive experiments were conducted year after year on the cane then cultivated with a view to selecting those stools or even individual stalks which gave the maximum yield of surcrose. This method of improving the varieties was obviously doomed to failure since the new plantings were made only from scions or cuttings from the old plant and thus no material change was made in the characteristics of growth and composition of the new plant. It was observed, however, that different varieties of cane existed in the various countries and even in the same country there might be found a number of different types of cane such as the white, red, and striped.

The main stalk of the cane as well as the underground rhizome contained buds which provided a means of reproducing the plant without the employment of seed, and it was observed that cane which differed greatly in its external appearance might be thus produced. By selecting for planting those stalks with exaggerated characteristics, different so-called varieties were obtained which were more or less constant. This method of producing variations seldom caused any material difference in the characteristics of growth, except in appearance, however, and consequently no marked improvement in the cane resulted. The above method of securing new varieties of cane was known as "bud variation" and the varieties thus produced as "bud varieties."

Speaking from a botanical standpoint many of the so-called varieties obtained by this methods as well as by means of seed are not in reality distinct varieties but merely casual variants.

Arrows of Louisiana striped sugar cane grown in the Philippines.

(*a*) Examining the flowers of sugar-cane by the aid of a dissecting microscope. Alabang experiment station.

(*b*) Emasculating or removing the anthers from the flowers of sugar-cane. Alabang experiment station.

(a) The first seedling cane produced in the Philippines.

(b) Germination sheds at the Singalong experiment station where the cane seedlings were produced.

(*a*) Seedling cane from the Hawaii No. 20. Hybridized with Louisiana striped.

(*b*) Seedling cane from the Hawaii No. 227 produced at the Singalong experiment station in 1915.

(*a*) Philippine Islands No. 2 seedling cane three months after transplanting. This is a very dark-red cane and originated from the Louisiana Striped.

(*b*) Philippine Islands No. 24 seedling cane three months after transplanting.

It is the general custom, however, to designate cane as different varieties when it shows a different color, slightly different growth, or any of the thousand and one other characteristics which distinguish the different kinds of cane.

Although great improvement had been made in the yield and quantity of various farm crops by careful cross breeding and seed selection, particularly in the sucrose content and yield of the sugar-beet plant, yet the growing of cane from seed and the improvement of that crop by the above means was considered an impossible task until comparatively recently for it was thought that through constant planting from cuttings the cane had lost its power of producing fertile seeds. There was an earnest desire on the part of the planters, however, to produce larger and sweeter varieties of cane, and yet the method of accomplishing this end through the medium of cane seed was no more than hinted at until the harvest of 1887–1888 when the announcement was made that Messrs. Soltwedel, of Java, and Harrison and Bovell, of Barbados, had succeeded in producing a number of cane plants from seed. This gave a new impetus to the subject for it was at once apparent that there was a ready means at hand of producing varied and distinct varieties by securing hybrid seed from the varieties which produced flowers.

Since the date of the above discovery the production of new varieties has rapidly advanced until to-day thousands of hectares are planted to varieties which originated from seed in the principal sugar-producing countries of the world, and indeed there are few countries in which the native or original cane is grown exclusively to-day.

So much has this discovery done for the planter that it is to-day possible for the plant breeder to produce a variety exactly fitted to the conditions of a plantation, no matter whether a cane is desired for light or heavy soils, for a long growing season from twelve to eighteen months like that of many parts of the Tropics, or for a short growing season of seven or eight months like that of the subtropics.

The introduction of the seedling varieties Demerara Nos. 74 and 95 was characterized by Director Taggart, of the Sugar Experiment Station of Louisiana, as a "Godsend to the sugar planters" of that State, since these, especially the D–74, were early maturers, and developed a remarkably high percentage of sucrose while yet very young. The above-mentioned seedling varieties were so favorably received in that state that in a few years they largely replaced the purple, striped and white cane

on many of the plantations. Although it is possible to produce cane seed only in tropical countries where the cane reaches full maturity, since it is necessary for the sugar cane as well as other plants to reach this stage before seed may be produced, the work of germinating and growing the seed has been by no means confined to tropical countries for the hothouse method has been resorted to and numerous plants were produced in Louisiana [1] and various other parts of the subtropics.

So far as the writer has been able to learn no attempt had been made to produce new varieties of cane from seed in the Philippine Islands previous to the year of 1913. A number of seedling varieties had been brought here from the various sugar-producing countries, however, the first of which were introduced in 1905 and although these proved very satisfactory in the countries in which they originated, yet they failed in one respect or another to exactly meet the requirements of a cane for the various sugar districts of these Islands. The varieties then grown most extensively on the different plantations consisted of the Negros purple, Luzon white, Pampanga purple, and Inalmon or Manila black. While the majority of the native varieties possessed the favorable characteristic of producing a high percentage of sucrose and giving a juice with a high purity, yet on the other hand they had the great disadvantage of producing low yields and also of having soft tissues thus making them more susceptible to attacks of insects and rodents, and requiring extra labor in harvesting the crop. In consequence of the objectionable features of the native cane, the imported varieties gained favor year after year, especially among the planters on the large estates where adequate crushing facilities were available to extract the juice from the large varieties as well as clarification facilities to handle the juices with lower purities.

After a careful study of the situation here the writer was convinced that through the medium of new varieties, cane might be produced from seed which would offer a great improvement over both the native and imported varieties. It was also apparent that excellent material was available for the carrying out of this work, since the native cane gave a high percentage of sucrose and purity, while various introduced varieties were heavy yielders of cane although they contained a fairly low percentage of sucrose and gave a juice with a low coefficient of purity. He was at the same time impressed

[1] Lousiana Bulletin No. 127.

with the fact that should the previous practice be continued there was a very great danger of introducing into the Islands, along with the imported cane cuttings, various diseases of sugar cane which have proved so destructive to the industry in a number of the sugar-producing countries of the world. Although the cuttings may be carefully fumigated before planting, it is impossible to eradicate the various organic and fungous diseases without completely destroying the cuttings.

Preparations were accordingly made during the arrowing season of 1914 for preliminary work in the production of varieties specially suited to the conditions here and at the same time to eliminate the danger of introducing distructive cane diseases. It was observed that certain varieties arrowed profusely beginning sometime during the period from November 5 to 20, depending upon the particular season, and extending into the latter part of December or fore part of January. The native varieties, however, seldom arrowed at all and when they did produce flowers it was invariably at a time somewhat later than that of the foreign varieties. The imported varieties of known merit under cultivation here at the time this work was started consisted of the Hawaiian seedlings Nos. 16, 20, 27, 227, 309, Demerara No. 1135, Louisiana striped, Rose bamboo, Yellow caledonia, and Lahaina.

In addition to a limited quantity of the native cane all of the above-named varieties were growing at the Alabang experiment station of this Bureau where seed with the seed-bearing parent known was collected for the preliminary experiments. This seed was planted in boxes containing a rich sandy loam, in the propagation sheds of the Singalong experiment station, and by the end of the third day much of the seed had germinated. After the period of a week the numerous small plants somewhat resembled very minute grass plants. Unfortunately these were later mistaken for grass by the inexperienced workmen in charge of cleaning the beds and were destroyed. Consequently the experiments of that year were lost. Arrangements were then made to safeguard against a recurrence of this trouble during the succeeding year, and Mr. E. D. Doryland, then superintendent of the experiment station, assumed personal charge of the planting and care of the new supply of seed. On account of the constant showers during the arrowing season of 1915 very little fertile seed was obtained and the work of producing hybrids by artificial means, using the foreign and native varieties as parent stock, was absolutely impossible since the showers kept from arrowing even those

native varieties that ordinarily produce flowers. In consequence of this abnormal condition of affairs seed could be secured only from the imported varieties.

The seed was collected during the latter part of November and the forepart of December and this was immediately planted in the propagation sheds at the Singalong experiment station. The germination was but fairly good due no doubt to the excessive rains of that season but by the end of December a number of plants had appeared which, through resembling very much tiny grass plants, were carefully guarded until they reached a size sufficiently large so that they might be distinguished from other plants.

Half shade only was used over the plants during the early period of their growth but after they became large enough to possess sufficient vitality no further protection from the intense rays of the sun was provided. When the plants reached a height of from 20 to 50 centimeters they were removed from the boxes and planted out in rows 1½ meters apart.

Since the first successful work on seedling varieties in the Philippines had started with this planting, each of the young plants when transferred to the permanent plot for future observation and experimentation was numbered consecutively beginning with Philippine Islands (P. I.) No. 1.

One hundred and eight plants or variants were produced the first year. A number of these were small and lacking in vitality, however, and it was not thought that more than two-thirds of the original planting would be available for future experiments. The above varieties were obtained from seed produced by the following parent stock: Nos. 1 to 34, inclusive, from Louisiana striped, 35 to 55 from Lahaina, 56 to 67 Rose bamboo, 68 to 80 Hawaii seedling No. 20, and 80 to 108 Hawaii seedling No. 227.

The Louisiana striped variety from which Nos. 1 to 34 were obtained is one of the old varieties which has long been under cultivation in the State of Louisiana. It was introduced into the Philippine Islands in the year 1910. (See History of Cane Varieties, this REVIEW, Vol. VIII (1915), p. 154). This cane grows quite large under conditions here and yields well, but the percentage of sucrose and coefficient of purity are not entirely satisfactory. It contains red and white stripes in which the colors vary to a slight extent according to the conditions under which the cane is grown and the stage of maturity. The nodes are quite long and have a groove usually running the

entire length. The fiber content ranges from $10\frac{1}{2}$ to 13 per cent. According to the latest observations made at the time of this writing, January 1, 1916, while the cane was yet very young, the new varieties presented the following appearance: Two were very dark or nearly black, resembling somewhat the Inalmon or Manila black; six were somewhat brown; and 10 were yellow or nearly white. The following numbers had perished after transplanting: Nos. 9, 24, 25, 26, 29, 30, and 32. Future observations taken when the cane reaches maturity will no doubt cause the above report on colors of the variants to be somewhat changed.

The Lahaina variety from which Nos. 35 to 55 were obtained was introduced into the Islands from Hawaii during the year 1909. This variety is medium green in color with a rosy blush along the main stalk. The internodes are of medium length and contain a fairly deep groove. The cane is soft and in consequence it is seldom found erect at harvest time. The fiber content ranges from $10\frac{1}{2}$ to 13 per cent and the sucrose and purity are slightly above the average for the foreign varieties, ranging from $11\frac{1}{2}$ to 14 per cent. According to the most recent observations taken, as in the previous case while the cane was yet immature, there were two very dark-red variants, two brown, and seven white. Numbers 39, 41, 42, and 45 to 51 inclusive, perished after transplanting.

The Rose bamboo variety from which Nos. 56 to 67 were obtained was introduced into the Islands from Hawaii in the year 1905. This is a small or medium-sized cane when grown under conditions here and is yellowish green in color with a rosy blush along the main stalk. It is a medium-soft cane and seldom stands erect at harvest time. The nodes are quite large and the internodes long with a slight groove. It stools but fairly well and is not much favored as a long-ratooning variety. The fiber content ranges from 10 to $13\frac{1}{2}$ per cent and the sucrose from 11 to 14 per cent.

Variants of the following colors were obtained from the Rose bamboo seed: One dark red, two light red, and three white.

The following variants perished after being transplanted: Nos. 59, 60, 61, 62, 64, 66.

Hawaiian seedling No. 20 from which Nos. 68 to 80 were obtained was introduced into the Islands from Hawaii in the year 1910. This is a light-green cane with a slightly rosy tint turning to straw color at maturity and when exposed to the sun. It is very hard and grows extremely erect, resembling

somewhat the yellow caledonia except that it has longer internodes and is not so subject to splitting. The internodes are slightly concave and somewhat zigzag. The nodes are prominent and set with round and well formed buds. The fiber content ranges from 11 to $13\frac{1}{2}$ per cent and the sucrose and purity compare favorably with the other introduced varieties.

From this seed the following variants were produced: Three pink and eight yellowish white. Number 78 perished after transplanting.

Hawaiian seedling No. 227 from which Nos. 81 to 108 were grown was introduced into the Islands from Hawaii in the year 1910. This variety has a yellow or straw color with a slightly rosy tint. When matured and exposed to the sun, it often contains blotches of a blood-red color. This is a hard cane which grows very tall and erect. The internodes are long, slightly zigzag, and contain a prominent groove. The nodes are large and set with small round buds. It arrows profusely at the age of eleven or twelve months in this climate and produces large spreading plumes of a dull ash color.

From this seed two light-red and nine yellowish-white varieties were obtained. The following numbers perished after transplanting: Nos. 81, 87, 88, 89, 90, 91, 92, 94, 97, 98, 99, and 101 to 108, inclusive.

At the age of seven months after transplanting, the new variants ranged from one meter to two and one-half meters in height and showed signs of possessing varied characteristics of growth. Some of the variants appeared to be extremely hardy and made an excellent growth from the start, while others were spindly and lacking in vitality. Many of the latter had already perished before the above period. Some variants grew extremely erect and showed every indication of having a hard, firm tissue, while others were recumbent. Some produced stools with from two to three times the number of stalks usually produced by either the native or imported varieties while others contained only one or two stalks to the hill and upon close examination of the root system it was observed that the rhizomes were almost entirely undeveloped.

It is interesting to note that during the first year the growth of seedling cane is more or less sluggish and consequently it would not be wise to start the process of elimination at this time unless certain of the seedlings should show signs of possessing some organic disease. It is in fact to a great extent a case of

the survival of the fittest for during this time the weaker and less fit varieties usually perish. After the cane is once cut and the planting extended by cuttings as well as a ratoon crop produced, the dominant characters become more or less stable and reliable information on each variant may then be obtained.

Careful observations will be recorded each week on the different variants and as soon as the cane reaches sufficient size it will be cut and the entire stalk used for planting in order to extend the area sufficiently for more thorough observations as well as to obtain results on yields and chemical composition of each variant.

It is during this time that the process of elimination will be started and those variants which prove to be below the standard will be discarded. Among the characters aimed at for a variety suited to the conditions here will be: (1) High available sucrose (i. e., a high percentage of sucrose, as well as a fair average purity of the juice); (2) yield of cane; (3) ratooning power of the cane; (4) fuel value of the cane (i. e., the fiber content); (5) resistance to extremes of drought and wet weather; (6) suitability to heavy and light soils; (7) resistance to attacks of insects and diseases, (8) condition of the tissue of the cane, whether soft or hard; (9) condition of the buds, their germination power; (10) habit of growth, whether straight or recumbent; (11) maturing period; (12) milling quality, etc.

So encouraging were the results of the experiments during the past year that it was decided to give special attention to the work on seedling cane during the present maturing season and endeavor to produce some hybrid variants from known parent stock in which each member possessed special merits.

The first arrows appeared with the Hawaii No. 20 variety on November 8, and five days later the Louisiana striped along with several of the other imported varieties began arrowing. On November 15 the work of selecting those stools containing the largest and most vigorous stalks from the varieties used as the parent stock was started.

Arrows from the different varieties were removed to the laboratory for the examination of the flowers under a dissecting miscroscope and the condition of the pollen grains was very carefully studied. It was observed that the greater portion of the flowers were well supplied with normal pollen and that only two varieties contained little or none. The following is the report on the condition of the pollen as observed during this study in November and December of the present season.

*Normal pollen.*

| Well supplied. | Poorly supplied. | None. |
| --- | --- | --- |
| Louisiana striped | Badila | Inalmon. |
| Lahaina | Mauritius melagache | Chenois. |
| Hawaiian seedling No. 16 | Demerara No. 95 | Uba. |
| Hawaiian seedling No. 20 | Louisiana purple | |
| Hawaiian seedling No. 27 | Striped Singapore | |
| Hawaiian seedling No. 69 | Negros purple | |
| Hawaiian seedling No. 227 | Luzon white | |
| Hawaiian seedling No. 309 | Pampanga purple | |
| Demerara 1135 | | |
| Rose Bamboo | | |

Since the arrows on the large cane were located from 4 to 5 meters above the ground it was necessary to arrange a portable platform somewhere near the arrows upon which the work of emasculating the flowers could be performed in order to eliminate the bending of the stalks out of their natural position.

It was observed that the main branches in the central portion of the arrows produced the largest and most perfectly formed flowers while those on the branches near the extremes were usually smaller. The interval between the first appearance of an arrow and its complete emergence from the leaf-sheath ranged from two to four days, while it required from two to three days after the flowers appeared for their organs to be sufficiently developed to begin to distribute pollen. In consequence of this condition it was necessary to remove the flowers on the upper branches as soon as they appeared in order to prevent the pollen from the older and more matured flowers above from falling upon the stigma of those flowers used for the production of hybrid seed.

Rectangular frames covered with mosquito wire and a very fine grade of muslin or paraffine paper were used to protect the arrows from foreign pollen. These frames were each 20 centimeters square and 50 centimeters long and contained a small hole at the bottom through which was passed the stem of the arrow. The cages were supported on bamboo poles in order to leave the arrow as nearly as possible in its natural position. The boxes opened longitudinally which permitted the free entrance of the arrow as well as observations of the flowers from time to time and the introduction of pollen. The arrows intended for treatment were inclosed in cages immediately after they began to appear beyond the leaf sheath and the upper branches were removed as fast as they were produced. The dissecting microscope as well as a high-power hand lens were used on the platform in the field in the carrying out of this work. All of the upper branches as well as the majority of the lower ones

were removed leaving from five to six in the central portion of the arrow. These were carefully examined each morning just after the dew had dried off since it is at this time of the day that the flowers open. Just as soon as the flowers were sufficiently developed for the anthers to be detected the latter were clipped off with very small pointed scissors. Extreme care was necessarily exercised in every case that none of the anthers had opened before their removal in order to eliminate any possible chance of self-pollination. Since the stigma of the cane


FIG. 7. (*a*) Flowers of sugar cane just before opening. (*b*) Sectional view of the flower after opening. 1, ovary; 2, anthers; 3, styles. (*c*) Mature flowers of sugar cane.

flower in common with that of many other flowers usually matures slightly before the complete development of the pollen in the same flower, it might seem that the task of producing hybrid seed would be extremely easy and indeed it would be if there was only one flower on each arrow, but on account of there being present on the same plant numerous flowers in all stages of development, there is in reality a very poor chance of producing hybrid seed in those varieties which produce an abundance of normal pollen, unless artificial means are employed.

Pollen from the variety selected as the male parent was shaken over the emasculated flowers and an arrow containing numerous

well-developed flowers was placed inside the cage with its stem in a bottle of water to keep the flowers fresh, after which the arrow was again inclosed in the cloth-covered cage. This operation of pollenizing the flowers was performed once each day for at least one week after the emasculation of the flowers, care being exercised to effectively exclude foreign pollen during the operation. The cages were opened only when the air was very calm in order to prevent foreign pollen from being carried there by light gusts of wind. The flowers were then left from one week to ten days for the seed to mature after which they were removed to the propagation sheds at the Singalong experiment station and planted in boxes containing rich sandy soil. Both the hybrid seed and that which was collected from the untreated flowers germinated exceedingly well.

From three to six days were required for the germination. The boxes were kept under half shade and the plants were watered each morning. By the end of one month the young plants ranged from 2 to 5 centimeters in height and at this time the larger ones were transplanted into individual bamboo tubes or earthen jars each of which was about 10 centimeters in diameter. Just before the heavy rains appear in July the young seedlings will be transplanted to a well-drained field and given permanent numbers. It is not presumed that all or even a very great portion of the plants from the hybrid seed will yield superior canes for the Philippines even though the parent stock on both sides possessed certain favorable characteristics. It is a well established fact that there is always a great element of chance in the production of hybrid plants and where one or both of the parents were complex hybrids themselves the probability of producing plants with varied characteristics becomes the greater. The production of superior strains of sugar cane entails a great deal of care and attention, and once the new varieties are produced almost endless experimentation and several years' observation are required before the promising varieties may be distinguished. At the same time the plant breeder is favored by the fact that once the new strain is fully established, it will remain constant since the future plantings will be made by vegetative propagation.

# DEMONSTRATION AND EXTENSION WORK IN THE PHILIPPINE ISLANDS.

By E. F. SOUTHWICK, *Acting Chief, Demonstration and Extension Division.*

Agricultural demonstration in the Philippine Islands had its real beginning in the year 1911, when work was started in the Provinces of Cebu, Iloilo, and Capiz. It had been the plan of the Bureau for several years previous to organize such a branch but unfortunately this was prevented from time to time by unforeseen conditions. In fact extension work was first undertaken in 1907 when an investigation of the agricultural conditions of the different provinces was made. Some two years later, several men well qualified for such duties were obtained from the United States, only to be assigned, upon their arrival, to rinderpest quarantine work where the services of every available man of the Bureau were of the utmost necessity at the time. However, in the early part of 1911, a lecture campaign was carried out in eighteen provinces, and it was found possible to send men into the Provinces of Cebu, Iloilo, and Capiz to make a preliminary agricultural survey of these districts preparatory to demonstration work. It was several months later when seed distribution and plot work were started, which marked the actual beginning of agricultural demonstration. During the following year of 1912 this work was extended to the Provinces of Nueva Vizcaya, Batangas, and the Mountain Province. The territory covered was steadily increased until the year 1915, when work was being carried on in twenty-four provinces and three subprovinces. It is to be regretted that since that time it has been necessary to reduce this territory covered to a certain extent on account of lack of both sufficient funds and qualified personnel. Nevertheless, the standard of work in such provinces as have been covered has been such that good progress has been made.

As in all untried undertakings the beginning was necessarily small, but development has been both rapid and sure. In fact it was more rapid than subsequent funds would allow, so that certain reductions had to be made in both personnel and ter-

ritory. At the close of the calendar year 1911, the field force of the division of demonstration and extension consisted of one Filipino and three American inspectors. They were working in three provinces and for the main part with two crops, corn and sugar cane. During the following year work was started in additional provinces and the force increased accordingly. Thus did the project progress until at the beginning of 1915 there were twenty-two Americans and fifty Filipinos employed in the division. The territory covered consisted of twenty-three provinces and one subprovince. Unfortunately it was necessary to curtail the work to a certain extent, so that at the end of the year 1916 there was a personnel of eleven Americans and fifty-two Filipinos, covering a district of eighteen provinces. However, this does not mean such a great curtailment in the work as the above figures would indicate, as the decrease in personnel largely represented such men as were least qualified for the work. Likewise with the provinces, those were first dropped which seemed least interested and least in sympathy with what was being done. While in the beginning demonstrations were carried on with only two crops—corn and sugar cane—the number has been steadily increased until at the present time there is not an economic crop in the Islands that is not handled. Although it has been impossible to cover every section of all the provinces wherein work has been organized, it has been the policy to first station men in those sections best adapted to agriculture. The progress of the work has not been confined to the extension of territory and crops handled, but other phases of demonstration and extension have been taken up, two of the most important of which are public breeding and the establishing of agricultural demonstration stations. Both of these have become highly important features of the work and the farmer is becoming more aware of their value every day.

Like other countries the Philippines has its own peculiar problems that have to be met and overcome before the farmer is willing to consider the adoption of new methods and crops. Such problems can only be solved by the most persistent and patient efforts. They are for the most part founded upon suspicion and superstition. Perhaps the greatest of these is the farmer's inability and unwillingness to grasp what is told him. It is practically an impossibility to induce a planter to change his methods by talking to him, no matter how convincing the arguments or how promising the returns; he must first see it with his own eyes. Even then it may be necessary to repeat a second and a third time in order to remove any doubt that

may still be in his mind. Such a condition as this can be overcome only by a demonstration of the fact propounded, which is best done by means of a plot maintained on the land itself. The system whereby large land holders rent their fields on crop shares is not generally conducive to agricultural improvement. The land owner is not for the most part interested in agriculture further than to reap his share of the harvest; it is generally difficult to deal with him directly, as it is seldom that his home is in the same section as his land; also, he is not anxious to compel his renters to change their customs for fear of causing discontent. The renter fears to do anything different without the consent of the owner and he is usually too poor to experiment. In former times the farmers were swindled to such an extent that it became utterly impossible for them to trust strangers, and as a result they still look upon an unknown person with considerable suspicion. This is especially true when something is offered for nothing, as is the case in plant distribution and plot demonstration work. They cannot help but believe that a scheme to take their crop or land is afoot, and to gain their confidence is often a very delicate proposition. It sometimes happens that such persons must be given up entirely. It is seldom that a new coöperator can be trusted to do what he is told. If left with instructions, he will invariably follow his old methods so that each and every operation must be done by the help of and under the eye of the inspector. It often takes more than a single season to overcome this. The one-crop system prevails in nearly every section of the Islands, and it has become so well established that it is only when this crop fails that others are planted to any appreciable extent. It is with considerable difficulty that a farmer is prevailed upon to again plant his land with other crops after the one crop has been harvested. It is the one crop or nothing. Land adapted to various secondary crops will lie idle during the entire interseason because the one crop has produced a yield sufficient to maintain the planter until the next havest.

Closely allied to the above system is the reluctance with which the common people adopt new food stuffs. Their diet is extremely simple and narrow and it is only when the principal articles are lacking that new ones are substituted. Thus the introduction of new and unknown food crops is very difficult. The lack of animal power for hauling improved implements has been a problem that has been only partly met. This was done by attempting to secure implements adapted to the animals used, which, although an improvement over the native implements, are

far from being all that could be desired. The draft animals, which consist of the carabao and bull, are invariably used singly for farming operations, and all attempts to induce the planters to use them in multiples have thus far failed. In fact it is only the larger planters that own more than a single animal. Thus it is that proper preparation of the soil and cultivation of crops are carried on with great difficulty.

Among the foremost natural agents that have to be contended with are typhoons, floods, droughts, and locusts. Although these are, with the exception of locusts, entirely unavoidable, they are discouraging in the extreme and often cause dissatisfaction or even the loss of coöperators. The question of transportation has caused the work to be confined to the immediate locality of the good roads. This is unfortunate as it is not always that such highways traverse the best agricultural sections. However, off the main roads travel is so difficult during certain periods of the year that to include the outlying municipalities and districts an inspector would use his entire time in traveling from one place to another, whereas with the present system little time is lost in this way. The problem of securing properly trained men has been a very difficult one. This has been handled in various ways until the present method was put in vogue which seems to accomplish what is required. Only men with agricultural training are used. They must be well grounded in the principles of agriculture and of good personal appearance. Their first assignment of duty is with the best organized and most progressive project. Here they remain working with experienced demonstrators until it is considered they have grasped sufficient knowledge of their duties to warrant their working alone, when they are transferred to a district of their own. While training their work is divided into three parts: Working as a laborer on the demonstration station, in charge of the station itself, and doing agricultural demonstration work among the farmers. The time employed in this manner depends entirely upon the man.

It has been learned through experience that the one important factor in the success of demonstration and extension work is the organization of forces. Men of high individual merit will fail to produce desired results unless they pay proper attention to this feature. It is also true that men of ordinary ability will prove successful demonstrators when given the aid and advice that they require. With practically all inspectors, excepting perhaps such Americans as have had previous experience, it has been found that results can be obtained only under the

strictest of supervision. The work to be done must be outlined from week to week and the district must be inspected to see that instructions are being followed out. Up to the present time the organization best suited to the conditions in the Islands is a supervisor for each province with enough assistant inspectors in his charge to cover the district, allowing each assistant only such territory as he can thoroughly handle. In most provinces this will not include more than four municipalities but this depends, to a large extent, upon the relative distance between such municipalities and the transportation available. In charge of several provinces is a supervising inspector whose duty it is to travel from province to province within his designated district and to see that the proper results are being accomplished. His dealings are principally with the inspectors in charge of the provinces yet he must be sufficiently acquainted with the details of his work to give advice relative to the most minute operations. He will carry successful practices from one province to another and he will close that otherwise unbridged gap between the office and the field forces. He is responsible for all operations carried on within his district. Only under such supervision as this can any definite results be obtained. Otherwise the men get unenergetic and follow the lines of least resistance; they get out of touch with the central office; and realizing they are not looked after, work only when it is convenient.

Great care must always be exercised to avoid having districts too large for proper operations. This is especially true of supervising inspectors and assistant inspectors. There is no reason why a supervisor cannot handle an entire province without any difficulty. A supervising inspector should be able, without undue effort, to visit his entire district once a month regardless of season or conditions. An assistant inspector who has a territory too large spends an undue amount of time in traveling from one place to another; he never becomes thoroughly acquainted with either his territory or the people therein; his work suffers from lack of attention; and because he is unable to accomplish what is expected and required of him he loses ambition in the work. It is far better to have a small district intensively demonstrated than a large one only partially. Where work is intensively carried on the adoption of teachings is much quicker and more universal, more people are reached and the results much more marked. Furthermore, such a district needs less attention after a certain period of working so that the territory covered can be gradually extended as the people gain confidence in the

demonstrator. Even an unquestioned demonstrator will have difficulty in successfully administrating a district that is larger than he can conveniently handle.

The loss of efficiency due to frequent changes in personnel can hardly be figured in an economic way, but that there is a loss which is in direct proportion to the number of changes is readily comprehensible. New inspectors always require considerable time to become acquainted with the methods and policies of the Bureau. Their duties are new, and they are thrown upon their own resources to such an extent, that they are at a loss to know where to begin. Their knowledge of general conditions is vague, and of the particular district in which they are stationed, usually nil. They must necessarily learn their relations to the farmers and the officials. All in all it requires from six months to one year before a new inexperienced man becomes a useful demonstrator. Although changes in personnel are unavoidable and often for the good of the service, they should be as few as possible. This may be done by exercising the utmost care in acquiring new inspectors and in keeping those that prove their worth. The transferring of demonstrators or inspectors from one province or one locality to another, although not as detrimental as changes, has a tendency to retard progress and frequent changes of this kind should be guarded against. An experienced man finds it necessary to become thoroughly acquainted with his territory before attempting any actual demonstration work. This preliminary survey requires from one to three or four months according to the size of the district and the abruptness of the transfer. Where one inspector relieves another there may be a less appreciable break in the work but progress is hindered until the work has become readjusted to the methods of the new demonstrator. More progressive work can be carried on where transfers are kept at a minimum and those that are absolutely necessary made so as to avoid any abrupt changes in the manner of carrying on the work.

That the five years of experience that must be credited to demonstration and extension work have brought about several revolutionary changes in certain branches cannot be denied. This has been very marked in both plot and lecture work. When demonstration plots were first inaugurated they were of varying sizes but for the most part very small, seldom exceeding one-fourth of a hectare in area; they were situated wherever it was convenient for the coöperator with no thought of his neighbor; they were planted only with seed that was strange to that local-

ity and for the most part untried; they were prepared and cultivated with only improved implements; and they were cultivated and cared for whenever it was possible to induce the coöperator to follow instructions. Plots managed under the above-named conditions failed to create interest on the part of the coöperator or his neighbors. The draft of the implements was considered too heavy for the animals and in the majority of cases the resulting crop was useless to the grower or not adapted to his requirements. He was not interested and the results did not impress him, so the work had failed in its purpose.

The above conditions gradually changed until the farmer was planting his own crop in his own way but under the supervision of a demonstrator. He now uses his own plow but he plows more thoroughly; he uses his own seed or seed which he knows, but which has been selected; he plants it practically the same as he always did except that he uses less seed and sows it at a greater distance. The plot is of sufficient size to be an economic factor and is situated on land where the neighbors can see it during the entire season. The coöperator is interested in it because it is part of his own crop, and although he cannot see how the little differences in plowing, planting, and cultivating can affect the results he is curious enough to want to see it through. The introduction of improved implements and varied methods can be brought about very slowly and only after it has been demonstrated that the inspector really can accomplish things that the farmer himself failed to see.

The introduction of new crops should be done very gradually and should be accompanied by propaganda relative to their value and use. Where formerly plots were placed with little or no discretion they are now limited to such places as are easily accessible and conspicuous to the public. Such plots are labeled with sign boards. Much time was previously wasted by inspectors trying to attend plots situated in distant sections where travel was difficult. This is doubtless the proper spirit to show in such work but the results accomplished do not warrant the expense in either time or money, when by other methods so much more may be done.

Lecture work has experienced several changes until at present very little is done along this line except when accompanied or supplemented by other branches of the work. When demonstration was first organized lectures were given in great numbers before large audiences, but it became evident that little was being accomplished in this way. Later these lectures were given

when supplemented with demonstration plots, and it could be seen that some good was being done by this method. From this developed the giving of impromptu lectures in the field accompanied by actual field practices. Although the people in attendance are much fewer in the field, the actual good accomplished is infinitely greater. The few both hear and see, and they question the demonstrator and force him to show his hand, for with the farmer of the Islands seeing is believing. Thus it has developed that a heart-to-heart talk with ten or fifteen people in the field where they are working accomplishes infinitely more than a lecture before two hundred people in the municipal building or elsewhere.

# EFFECTS OF FORMALIN-BORDEAUX MIXTURE ON CITRUS CANKER.

By E. D. DORYLAND, *Agricultural Inspector.*

Since completing the preliminary investigations on citrus-canker control with formalin sprays at the Singalong station during 1915, other experiments of more extensive scope were taken up at the Lamao station, and, as a result of these experiments, a possible remedy for the disease seems to be in sight. The work at the Lamao station was started on January 29, 1916.

The sprays used at Lamao had the following compositions:

*Formaldehyde-water:*
- No. 1, 0.32 per cent.
- No. 2, 0.38 per cent.
- No. 3, 0.475 per cent.

*Formalin-Bordeaux:*
- No. 1, 0.32 per cent.
- No. 2, 0.38 per cent.
- No. 3, 0.40 per cent.
- No. 4, 0.475 per cent.

*Creolin emulsion:*
- No. 1, Saponified—
  - 300 cubic centimeters linseed oil.
  - 58 grams sodium hydroxide.
  - Add 4 liters creolin.

(Made to a volume of 200 liters with water.)

*Creolin-formalin emulsion:*
- No. 1, Saponified—
  - 300 cubic centimeters linseed oil.
  - 58 grams sodium hydroxide.
  - Add 4 liters creolin.
  - 2 liters, 40 per cent formaldehyde.

(Made to a volume of 200 liters with water.)

The addition of linseed oil to the creolin emulsion so as to increase the body of the spray was suggested by Dr. Edson, of the United States Department of Agriculture. It was hoped that this spray composition would solve both the canker and the

plant-lice problem at the same time, as plant lice are known to develop rapidly wherever bordeaux mixture is used in repeated applications.

All three of the formaldehyde sprays and Nos. 1 and 2 of the formalin-bordeaux solutions were discarded as unsatisfactory after a trial period of two months and only three sprays, formalin-bordeaux 0.475 per cent and 0.4 per cent, and creolin-formalin emulsion (0.4 per cent formaldehyde), were kept for further trial.

Experimental work at the Singalong station, during 1916, led to the following conclusions as to the percentage tests carried on at that station.

The greatest percentage of formaldehyde that most commonly cultivated citrus plants can withstand without seriously scalding the foliage, is between 0.4 to 0.5 of one per cent. However, some individual plants can withstand as high as 1.5 per cent of actual formaldehyde in single applications without killing or even severely scalding, although, of course, they cannot withstand repeated applications at this rate.

After spraying the plants at the Lamao station for three and one-half months at 10-day intervals the canker had completely disappeared from the 0.4 of one per cent formalin-bordeaux plot, and the disease appeared to be well under control on the creolin-formalin emulsion plot. Nevertheless, 5 months after the last spraying, the plants sprayed with creolin-formalin emulsion were more badly infected than before spraying was started, and consequently this spray was also discarded.

It required four months time in which to rid the plants of the disease where formalin-bordeaux 0.475 per cent was used. Thus from the results obtained it would appear that formalin-bordeaux 0.4 per cent is the logical mixture to use as this strength of solution gave more satisfactory results than any other spray hitherto used.

### DIRECTION FOR SPRAYING WITH FORMALDEHYDE SPRAYS ON PLANTS INFECTED WITH CITRUS CANKER.

Before making up the solution, preparation for spraying should be made by removing all badly infected branches throughout the citrus orchard. All the trash in the immediate vicinity of the trees should be cleaned out and burned with the pruned refuse from the plants. This precautionary measure should be exercised so as to eliminate all possible danger of reinfection from uninjured organisms that may have been

deposited on the trash from fallen leaves, etc. This cleaning up will also expose the soil surface to the effects of the sprays, so that live organisms that may be therein contained will be exterminated.

After completing the cleaning work a thorough application of spray should be given to the trees every ten days and a like application to the soil immediately under the trees every 20 to 30 days as the case seems to warrant; it is essential that the soil should be sprayed before and after each cultivation. The spraying should be continued until the disease has disappeared, and should the disease reappear, all infected portions should be removed and the trees given repeated sprayings with formalin-bordeaux. It will perhaps be necessary to keep the citrus orchard under close supervision for several years in order to combat any reappearance of the canker.

### DIRECTIONS FOR MAKING FORMALIN-BORDEAUX SPRAY.

A Bordeaux mixture of 4–6–50 solution should be made up and with this mixture as a diluting agent a 0.4 of one per cent solution of formaldehyde should be made. The resulting product will be the desired formalin-bordeaux mixture.

The bordeaux in this solution acts not only as a fungicide but also as an adhering agent, which holds the formaldehyde on the sprayed area for a greater length of time than would the water solution alone. This spray has a tendency to favor plant-louse development, consequently applications of some oil-emulsion spray may be necessary for the control of these pests.

### CONCLUSIONS.

The formalin-bordeaux spray has proved satisfactory on small plots of badly infected areas and during the following rainy season reinfections were noticed (five months after the last spraying) on the edges of the plots bordering on the unsprayed portions. Apparently the disease had been carried over from the infected plants outside the plots.

However, allowing the benefit of a doubt in favor of the incomplete destruction of the disease by former applications of spray material, credit must be given to the spray as a control measure, as the disease had completely disappeared from the plants at the time the spraying was stopped and the plants remained uninfected until the beginning of the rainy season.

All evidence points to reinfection from outside sources, but this cannot be definitely proved until the whole of the Lamao

station is sprayed as all the citrus plants with the exception of immune plants are badly infected.

Spraying experiments carried on during the wet season of 1916 gave results corresponding to those obtained during the dry period of the year.

There were twenty-day intervals between applications, and results seem to show that such periodic spraying is nearly as effective as the 10-day intervals in the same period of time.

# PLANT NAMES.

By P. J. WESTER, *Horticulturist in Charge of Lamao Experiment Station.*

The following editorial appeared some months ago in the Saturday Evening Post (Philadelphia, U. S. A.):

*Silly Place-Names.*—Some Blackfeet Indians, with a taste and respect for nature that shames the paleface, have protested to the Secretary of the Interior against the barbarous custom of tacking silly, meaningless, vulgar names to noble natural objects which the Indians long ago had named with appropriateness. A melodious word, with poetic significance and very likely commemorating some charming native legend, is calmly ignored in favor of Jones' Gulch, or Smith's Falls, or Dolly Lake.

It is even worse in the matter of towns. Nearly all the good names in North America are bestowed by the Indians or the early French and Spanish explorers. After them came the Anglo-Saxon, spattering the landscape with his own patronymics and other tasteless and meaningless proper nouns.

We can understand why a person with the imagination of a hitching post might prefer for a beautiful natural object his own name or that of a female relative, or some foolish Grand Falls, High Peak, Swift Rapids, and Broad Cañon; but we cannot understand why authority should permit him to vandalize that way. Unless there is some excellent reason to the contrary, authority ought to insist always upon the Indian names.

If we, even with some reluctance, admit the force of the above contentions relative to "Jones' Gulch," "Swift Rapids" and "High Peak," what then shall we say about the following names of tropical fruits and other plants: "Alligator pear," "Sweet cup," "Jamaica sorrel," "Vegetable oyster," "Egg fruit," "Hog plum," "Ceylon gooseberry," "Barbados cherry," "Surinam cherry," "Shoe flower," "Governor's plum," "Sweet sop," "Tree tomato," "Monkey nut," "Negro peach," "Monkey apple," "Velvet apple," "Bully tree," "Cucumber tree," "Tree melon," "Date plum," "Civet-cat fruit," "Wood apple," "Elephant apple," "Marmalade plum," "Cape gooseberry," "Peruvian cherry," "Cluster bean," "Yam bean," "Yard-long bean," "Snake cucumber," "Job tears," "Country potato," "Horse-radish tree," "Sapodilla plum," "Asparagus bean," "Monkey jack," "Moreton Bay chestnut," "Bengal quince," "Soursop," "Bullock's

heart," "Husk tomato," "Otaheiti gooseberry," "Golden apple," or "Potato tree." Can it be that any one with less than a "hitching-post imagination" could possibly have invented those names! One shudders to think of what might now be the names of our common temperate fruits and vegetables if their naming had been entrusted to the originators of the "Yard-long bean," the "Bullock's heart," "Soursop," "the Hog plum," or the "Monkey nut." Does it not seem evident that many of these barbarisms, which have been perpetrated alike upon an otherwise good language, an innocent public, and perfectly respectable plants, might have been devised by any one except an authority on plants and plant names, or how come we by such names as the "Vegetable oyster" or the "Governor's plum." One can imagine the derivation of the "Velvet apple," the "Surinam cherry," the "Otaheiti gooseberry," and the "Cucumber tree," even if one does not approve of these names, but speculation as to the origin of "Bully tree," "Country potato," "Water lemon" (not "melon"), and "Sweet cup" is a strain on the imagination.

None of the above mentioned or similar appellations are names of any of the very important tropical economics, and as they seldom meet the eye of the public in print the names have been a matter of indifference in the past. However, with the ever widening circle of agricultural research, in an endeavor to discover new sources of wealth or to gratify one's sense of enjoyment by the amelioration of hitherto obscure plants or the bringing to light of new ones, these conditions are rapidly changing, and we are on the eve of a period when names of plants that a generation ago were unknown to all but a handful of students to-morrow will be household words of the general public.

That there is a consciousness that "something ought to be done" in the matter under consideration is evident from the various articles that have appeared within the last few years.

One of the earliest of these, "Some Needed Name Standards," by Mr. O. W. Barrett, then chief of the division of horticulture of this Bureau, appeared in the November, 1912, issue of this REVIEW, and contains some excellent suggestions even though one may differ with Mr. Barrett relative to the practicability of adopting the name "maize" for the old established name corn (*Zea mays.*).

The proceedings of the Florida State Horticultural Society for 1916, contains an article entitled "Naming the Plants," along the same lines.

Something more than a year ago, the Agricultural News (Barbados), Vol. XIV, No. 353, 1915, contained an interesting article on "Scientific and Vernacular Naming." Having first discussed the botanical names, their origin, etc., the writer proceeds to consider the appropriateness and expressiveness, and the scientific or unscientific features of some of the vernacular names, and the resultant confusion consequent upon the vernacular synonymy. Having called attention to some of the objectionable features in some of the common names one cannot but wish that the writer had proceeded a step further and suggested a rule for the naming of plants in the vernacular, or at least a rule for the adoption of a common name, for it is probable that most if not all plants of any importance, whether economic or decorative, already possess one to several names in the language of their respective countries.

A consideration of the vernacular nomenclature of plants is hardly complete without reference to the synonymy, for the English language, as we have seen, not only includes some rather remarkable plant names but also a number of synonymous plant names, each of which is used in its particular locality to the exclusion of the others. For instance, *Hibiscus sabdariffa* is in the Philippines known as roselle, while on the mainland of the United States, in addition to this name, it also parades under the name "Jamaica sorrel," the "Tropical cranberry," and "Lemonade plant." In the British West Indies and India it is known as "Jamaica sorrel or "Red sorrel," and the Australians call it "Rosella." Can there be any doubt as to the desirability of the adoption of one of these names for universal use wherever American rule is acknowledged, not to say in all English-speaking countries?

If then one may assume that this question has been answered in the negative we may proceed to consider practical guiding rules in the adoption of standard names.

In the course of the systematization of the botanical names priority has been the principal consideration but while this has worked out very satisfactorily where the use of the names was limited to comparatively few people most of whom were well trained in botany, other considerations must also necessarily be recognized when it is remembered that in the present instance the names will be commonly employed by the every day people in conversation, in trade, and in the press. In part, at least, usage must of course be deferred to, but if a serious effort were made toward the adoption of one universal, standard name for a species in the English language, it is obvious that usage could

not play the principal rôle, for the simple reason that what would be usage in one country or a section thereof would not necessarily be so in another, and the matter would be apt to end in a deadlock.

It is believed that convenience, in the form of a short, distinct, attractive name, should be the chief consideration in an attempt to formulate a code for the standardization of vernacular names of plants.

Such codes as have already been formulated by American pomologists may here be considered as both interesting and instructive. F. A. Waugh devotes 32 pages to a discussion of pomological nomenclature in Systematic Pomology, 1914, and publishes the so-called "Lazy Club Code" and the "American Pomological Society Rules," which are quoted therewith.

### LAZY CLUB CODE.

1. The name of a variety of fruit shall consist of one word, or at most of two words.

In selecting names, simplicity, distinctiveness, and convenience are of paramount importance. Pitmaston Green Gage and Louise Bonne de Jersey are neither simple nor convenient. Gold, Golden, Golden Drop, Golden Beauty, Golden Queen, and Golden Prune, all given to different varieties of plants, are not distinctive.

The use of such general terms as seedling, hybrid, pippin, buerré, damson, etc., is not admissible.

Nouns must not be used in the possessive form. McIntosh's Red, Crawford's Early, Bubach's No. 5 must be written McIntosh, Crawford Early, and Bubach.

Numbers are to be considered as temporary expedients to be used while the variety is under trial.

The name of no living horticulturist should be applied to a variety without his full consent; and the name of no deceased horticulturist should be used without the general agreement of living horticulturists.

An author publishing a new variety should use the name given by the originator, or by the introducer, or else should choose the oldest discoverable local name, providing such name may conform to those rules without loss of identity.

2. In the full and formal citation of a variety name, the name of the author who first published it shall also be given.

Names would then take such forms as the following: Summer Queen, *Coxe;* or Henry (Jerolaman; or Sophie) (J. W. Kerr, Cat., 1894); or America, Burbank, *New Creations*, 1898, p. 5.

It is expected that such citations of names will be used only in elaborate works on pomology, in scientific publications, or in cases where they are necessary for clear discrimination of synonyms.

3. No two varieties in the same group shall have the same name, and the name first published for a variety must always be used to designate it. All names subsequently published must stand as synonyms.

The term "group" as here used shall be held to designate the large,

general groups specified by words in common language, such as raspberry, plum, apricot.

4. Publication consists in (*a*) the public distribution of a printed name and description, the latter; giving distinguishing characters of fruit, tree, etc., or (*b*) in the publication of a new name for a variety properly described elsewhere.

Such a publication may be made in any book, bulletin, report, trade catalogue, or periodical, providing the issue bears the date of its publication and it is generally distributed among nursery men, fruit growers, and horticulturists.

No one is authorized to change a name for any reason except when it conflicts with these rules.

In 1867 the American Pomological Society proposed the following rules:

1. No new seedling fruit shall be entitled to the recommendation of this society until its qualities shall be ascertained by at least five years' experience in more than one locality, and which is not at least equal to any similar variety of the first rank already known, or which, if only of second-rate flavor, is superior in vigor, hardiness, productiveness, or other important qualities or charecteristics.

2. No new fruit shall be considered as named until it has been accurately described by some person or committee known to be conversant with existing varieties, and such description shall have been published in at least one horticultural or agricultural journal, or some pomological work of acknowledged standard character.

3. The originator, or he who first makes known a new variety, shall be entitled to name it, and such name, if suitable, shall be adopted by the writer describing the fruit for the first time.

But if the name proposed is inappropriate, or does not come within the rules of nomenclature, the describer shall be at liberty to give a name.

When two persons have named or described a fruit the name and description first published, if according to the rules, shall have the priority.

4. In giving names to new varieties, all harsh, vulgar, or inelegant names, such as "Sheepsnose," "Hogpen," etc., should be avoided, and no name should consist of more than two words, excepting only when the originator's name is added. Charateristic names, or those in some way descriptive of the qualities, origin, or habit of fruit or tree, shall be preferred. They may either be of intrinsic properties (as Golden Sweeting, Downer's Late, etc.), or of local origin (as Newtown Pippin, Hudson Gage), of the season of ripening (as Early Scarlet, Frost Gage), of the form and color (as Golden Drop, Blue Pearmain), or which commemorates a particular place or person (as Tippecanoe, La Grange, Baldwin), or any other titles which may be significantly applied.

5. The descriptions of new varieties of fruits shall embrace the following particulars:

(*a*) An account of their origin.

(*b*) The fruit, its size, form, and exterior color; texture and color of the flesh; flavor, and time of ripening, with the addition, in stone fruits, of the size of the stone, adherence or nonadherence of the flesh, form of the suture and the hollow at the stem, and in kernel fruits of the size of

the core and seeds, the length, position, and insertion of the stalk, and form of the eye.

(*c*) The tree, its marked characters of growth, young and bearing wood, foliage and blossoms. In peaches, the form of leaf gland, and size of blossoms. In strawberries, the character of the blossoms whether staminate or pistillate. In grapes, the form of bunch or berry.

These rules were modified and adopted by the Society, in 1883, as follows:

1. The originator or introducer (in the order named) has the prior right to bestow a name upon a new or unnamed fruit.

2. The society reserves the right, in case of long, inappropriate, or otherwise objectionable names, to shorten, modify, or wholly change the same when they shall occur in its discussions or reports, and also to recommend such names for general adoption.

3. The name of a fruit should preferably express, as far as practicable by a single word, the charateristics of a variety, the name of the originator, or the place of its origin. Under no ordinary circumstances should more than a single word be employed.

4. Should the question of priority arise between different names for the same variety of fruit, other circumstances being equal, the name first publicly bestowed will be given preference.

Since the codes quoted apply to names of varieties, whereas species are considered in the present discussion, some of these rules are scarcely pertinent in the present case while again other rules are eminently so.

The following rules are suggested for guidance in adopting popular standard plant names with which may be incorporated such other rules from the codes quoted as may seem applicable:

1. In the selection of vernacular plant names, convenience, usage, and priority should be considered in the order of their enumeration.

2. Convenience, under which are understood distinctiveness, simplicity and euphony, should be of paramount importance; in other words distinctive, short, attractive names should be adopted.

3. In part, at least, usage necessarily must be deferred to, while priority, which takes precedence in botanical nomenclature, here would manifestly lead to impossibilities if consistently adhered to.

4. A species lacking a convenient common name may be named by a competent authority in a recognized standard publication; such a name should be accompanied by the Latin name, names already in use if any, and a short, concise description of the plant.

As a rule the native names of the economic plants of the Tropics furnish us with suitable names where the name in

English may seem undesirable, or else there are corruptions of the original names that are all that can be desired. For instance, compare the names Cucumber tree and Camia, Surinam cherry and Pitanga, Velvet apple and Mabolo, Yard-long bean and Sitao, Ceylon gooseberry and Ketembilla, Bully tree or Naseberry and Chico, Elephant apple and Vilatti.

However, there are instances where there is no suitable name available, under which circumstances the coinage of a vernacular name, unusual as it is, is believed to be as justifiable as the coinage of botanical ones.

No doubt the coining of new vernacular names may to many seem too radical a procedure. Yet on reflection why should we retain as names awkward and uncouth absurdities which were chance proposals, even though they possess a somewhat doubtful sanctity by having been more or less in use during a longer or shorter period of years, rather than to devise a new, more convenient name? Such a procedure would of course be in line with the continued use of the Farenheit thermometer in place of the Centigrade, or the antiquated common measures instead of the metric system. But if we want to be consistently conservative why then the railway, the telephone, or the wireless telegraphy and a thousand and one other modern inventions and conveniences? Why the evolution of the new and improved cereals, fruits and other economic plants? There is no progress without change.

It has been suggested that the name should be indicative of one or more characters of the plant or of the fruit. In coining new names this may of course be considered, though it is also well to remember that it is the too literal adherence to this rule that produces such absurdities as the "Yard-long bean". But on closer reflection is this really necessary? Laying aside the much mooted question as to what constitutes a species, all groups of plants so recognized may be regarded as distinct entities, and in the opinion of the writer their names should suggest this rather than call to mind something that has absolutely no relation to them except that they belong to the vegetable kingdom, or something to which they have a more or less fancied resemblance.

The mabolo, *Diospyros discolor*, which in some publications is referred to as the "Velvet apple," is a case in point. This beautiful fruit is shaped like the apple and has a velvet exterior, but it is not even closely related to the apple and absolutely dissimilar to it in flavor and quality; in other words

the name gives an entirely wrong impression of what the fruit is like. The name "Velvet apple" instead of Mabolo is here just as appropriate and expressive as if the apple were called the "Smooth mabolo." Yet this is a very mild and unobtrusive name. The "Bullock's heart" is another name more to the point. How many of those who have eaten this fruit have considered the impropriety of the name. "Bullock's heart!" The fruit in question is of course anything but the heart of a bullock. Then the name automatically suggests the slaughter house, blood and gore, of which the fruit itself is a veritable antithesis. Surely there are other names more appropriate. Again, Webster defines a "sop" as "anything steeped, dipped or softened in a liquid, especially in broth; something given to pacify." This definition is suggested as food for thought to the readers of this paper when next they partake of a "sour sop" or a "sweet sop." The "date plum" would naturally suggest a cross between the date and the plum; as a matter of fact, being *Chrysophyllum oliviforme,* it is related to neither. The numerous tropical "cherries," "apples" and "gooseberries" are not related to these temperate fruits and, frequently, they did not even originate in the countries the names of which are attached to them. Surely the affix "Alligator" and "Monkey" do not add to the attractiveness of the name of a fruit.

In most instances suitable and striking names for plants may be found merely by adopting one of the names in the native dialects. The plants are indeed rare which do not possess half a dozen or more. In a few instances such as the Asparagus, Feijoa, and Carissa, the generic name in Latin has been adopted as the vernacular also and there is no reason why this practice may not be extended where the names are short and serve their purpose well.

Where a genus contains more than one species of economic plants this is of course less practicable. In other cases abbreviations or contractions of the Latin name may make apt vernacular names, such as "Damia," proposed for *Macadamia ternifolia,* otherwise known under the unwieldy name "Queensland chestnut," and "Malpi," proposed for *Malpighia glabra,* in place of the Barbados cherry, in the "Food Plants of the Philippines." Some of the changes introduced in vernacular nomenclature in this paper may at first seem startling as does everything new or unusual, but after the novelty has worn off, it is believed that the proposed names will be found to be improvements upon those discarded. Whether or not they become gen-

erally accepted, together with the present paper they may nevertheless serve to call attention to the need of action relative to vernacular plant nomenclature. In the meantime, with apologies to the Agricultural News, while we are waiting for the standard universal vernacular plant names to make their appearance, writers on agricultural and horticultural subjects in the various parts of the Tropics would make their papers much more instructive and intelligible if they quoted the botanical names after the various popular ones, many of which are but little or not at all known outside of the countries of their origin.

# RESUMÉ OF THE FIBER-INSPECTION WORK OF THE BUREAU OF AGRICULTURE DURING THE YEAR 1916.

By M. M. SALEEBY, *Chief, Fiber Division.*

## SCOPE OF WORK.

The work of the fiber division during the year 1916 included the enforcement of the fiber-grading and inspection law (Act 2380), and also investigations and experiments pertaining to abacá (Manila hemp), agave and allied fibers, kapok, cotton, and miscellaneous tropical fibers of commercial possibilities. The distribution of fiber plants and seed was performed by the office of seed and plant distribution of this Bureau with the coöperation of the fiber division.

## FIBER GRADING AND INSPECTION.

As during the previous year, the enforcement of the fiber-grading and inspection law constituted the most important part of the work. The grading establishments having become thoroughly acquainted with the official standard of grading and the prescribed regulations governing the conditioning and packing of fiber, and the Government inspectors having profited by their experience in the past year, the system of grading and inspection on the whole was conducted with less friction and less difficulties than during the previous year.

The only factor which temporarily marred the smoothness and regularity of the work, especially during the early part of the year, was the presence in the market of considerable quantities of damaged fiber and fiber of untypical characteristics, as a result of the typhoons and floods which hit the southern Luzon and western Visayan provinces between October and December, 1915. The quantities of such fiber were so large as to render the task of supervising its proper grading and sorting extremely difficult and trying for our inspectors, particularly because a large number of the grading establishments in the localities affected by the typhoons and floods were so loath to

keep out of the standard grades all damaged and otherwise undesirable fiber. This experience indicates the necessity of the Government taking strong measures against the establishments concerned should there be a repetition of similar conditions in the future.

*Grading stations and establishments.*—There were designated during the year thirty grading stations and ninety-five grading establishments, an increase over the previous year of two stations and eight establishments.

The following table gives the names of the provinces, locations of the grading stations, and the number of grading establishments by class in each station:

| Province. | Grading Station. | Number of Grading Establishments by class. | | | | | | Total. |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | |
| Manila | Manila | 4 | 1 | 1 | 2 | 3 | 8 | 19 |
| Cebu | Cebu | 3 | 1 | | | | | 4 |
| Albay | Legaspi | | 1 | | 5 | | 1 | 7 |
| | Tabaco | 1 | | 1 | 4 | 1 | 1 | 8 |
| | Ligao | | | | 1 | | | 1 |
| | Virac | | | | 2 | | | 2 |
| Ambos Camarines | Daet | | | | 1 | 1 | 3 | 5 |
| | Naga | | | | 1 | 2 | 2 | 5 |
| | Calabanga | | | | | | 1 | 1 |
| | Goa | | | | | | 1 | 1 |
| | Iriga | | | | | | 1 | 1 |
| | Lagonoy, Lagonoy | | | | | 2 | 1 | 3 |
| | San Jose, Lagonoy | | | | | 2 | 2 | 4 |
| | Tigaon, Lagonoy | | | | | 1 | 1 | 2 |
| | Sagnay, Lagonoy | | | | 1 | 1 | | 2 |
| Sorsogon | Sorsogon | | | 1 | 1 | 1 | | 3 |
| | Casiguran | | 1 | | 1 | | | 2 |
| | Gubat | | | | 2 | 1 | | 3 |
| | Bulan | | | | 1 | | | 1 |
| Leyte | Tacloban | | 3 | | 1 | | | 4 |
| | Carigara | | 1 | | | 2 | 1 | 4 |
| | Palompon | | | | 1 | | | 1 |
| | Baybay | | 1 | | | | | 1 |
| | Maasin | | | | 1 | | | 1 |
| | Malitbog | | | | 1 | | | 1 |
| Samar | Calbayog | | | 2 | 1 | | 1 | 4 |
| | Catbalogan | | | | | 1 | | 1 |
| Surigao (N. Mind.) | Surigao | | | | 2 | | | 2 |
| Misamis (S. Mind.) | Cagayan | | | | | 1 | | 1 |
| Davao (S. Mind.) | Davao | | | | | | 1 | 1 |
| Tayabas | Mauban | | | | | | 2 | 2 |
| Total | 30 | 8 | 9 | 5 | 29 | 19 | 27 | 97 |

The following list gives the names of the grading establishments, their locations, distinguishing marks (press marks), and the lot numbers allotted to them. A blank in the "Press mark" column signifies that the establishment uses a special

house mark for each grade. These house marks are given in a separate list:

| Name of establishment. | Press mark. | Grading station. | Lot numbers. | Class of establishment. |
|---|---|---|---|---|
| A. Chan Linte | AO | Calbayog, Samar | 22601-22700 | 4 |
| A. Yusingco Hermanos | AYS | Surigao, Surigao | 25001-25200 | 4 |
| Adriano Favorito | AF | San Jose, Camarines | 22701-22800 | 6 |
| Andres Garchitorena | HS | Sagnay, Camarines | 25401-25600 | 5 |
| Angel Camara | JC | Gubat, Sorsogon | 5701-5900 | 4 |
| Babcock & Templeton, Inc | BT | Manila | 15401-15600 | 6 |
| B. A. Lim Biengco | BA | Lagonoy, Camarines | 2401-2500 | 5 |
| B. E. Jao Oge | BJG | Legaspi, Albay | 19101-19300 | 4 |
| Balbino Campa | BC | Mauban, Tayabas | 22101-22300 | 6 |
| C. Itoh & Co | CI | Manila | 11301-11500 | 4 |
| Colea & Co | CF | San Jose, Camarines | 6101-6300 | 5 |
| D. B. Monasterio | DBM | do | 17301-17500 | 5 |
| S. B. Monasterio | MH | Tigaon, Camarines | 17501-17700 | 6 |
| Dy Buncio & Co | DBC | Tabaco, Albay | 12101-12500 | 4 |
| Do | N/DBC | Naga, Camarines | 12501-12700 | 5 |
| Dy Chi Chuan | DCC | Calbayog, Samar | 23001-24000 | 6 |
| E. Diaz & Co | EDC | Legaspi, Albay | 3501-3800 | 4 |
| Fausto Ormachea | FO | Tabaco, Albay | 13901-14200 | 6 |
| Fernandez Hermanos | | Manila | 16801-17000 | 5 |
| Do | | Davao, Mindanao | 26001-26100 | 6 |
| Findlay, Richardson & Co (Ltd.) | | Manila | 8001-8100 | 6 |
| G. Martini (Ltd.) | GMM | do | 15201-15400 | 2 |
| Gavino Barretto | PTS | Tacloban, Leyte | 21501-21800 | 2 |
| Germann & Co. (Ltd.) | | Manila | 3101-3300 | 6 |
| Guevara & Alonzo | GA | Goa, Camarines | 11101-11300 | 6 |
| Gutierrez Hermanos | | Legaspi, Albay | 1101-1600 | 4 |
| Do | | Lagonoy, Camarines | 1601-1800 | 5 |
| Do | | Maasin, Leyte | 1801-2000 | 4 |
| Do | | Bulan, Sorsogon | 2201-2400 | 4 |
| I. Ihara | II | Manila | 17001-17200 | 6 |
| Irineo Salazar | IS | San Jose, Camarines | 25201-25400 | 6 |
| J. Narazaki | MTI | Manila | 11901-12100 | 5 |
| Jao Juntiao & Co | JT | Sorsogon, Sorsogon | 5501-5700 | 4 |
| Joaquin Muñoz & Co | JMC | Legaspi, Albay | 16401-16800 | 4 |
| José Dyogi & Co | JDC | do | 27101-27200 | 6 |
| Juan Navas Sioca | JNS | Catbalogan, Samar | 18901-19100 | 5 |
| Juan Pimentel | JP | Daet, Camarines | 19501-19700 | 6 |
| Ker & Co | | Cebu, Cebu | 4301-4500 | 2 |
| Do | | Manila | 4501-4700 | 3 |
| Li Seng Giap & Co | N/LSG | Naga, Camarines | 14201-14400 | 5 |
| Do | D/LSG | Daet, Camarines | 14401-14600 | 4 |
| Lim Ueco & Co | LV | Gubat, Sorsogon | 15801-16000 | 5 |
| Lutz & Co | | Manila | 17201-17300 | 6 |
| M. Tagawa | JMT | do | 12701-12900 | 6 |
| Macleod & Co. (Inc.) | MAC | do | 12901-13400 | 1 |
| Do | PC | Cebu, Cebu | 13401-13900 | 1 |
| Do | | Baybay, Leyte | 26601-27100 | 2 |
| Mariano Q. Dy Tue & Co | MD | Tabaco, Albay | 24401-24800 | 5 |
| Martin de Achaval | AD | Ligao, Albay | 19301-19500 | 4 |
| Miguel Sanchez | MS | Calabanga, Camarines | 21801-21900 | 6 |
| Mitsui Bussan Kaisha | OTS | Manila | 26101-26400 | 4 |
| Narcisco Alegre | | Casiguran, Sorsogon | 3801-4300 | 2 |
| Ng Seh Pee | UF | Carigara, Leyte | 27201-27300 | 6 |
| Ohta Development Co | KSO | Manila | 7301-7500 | 5 |
| Ong Saco & Co | OHC | Daet, Camarines | 22901-23000 | 6 |
| Ortiga Hermanos [a] | PO or LY | Tacloban, Leyte | 4701-5200 | 2 |
| Ortiga Hermanos | OH | Calbayog, Samar | 5201-5500 | 3 |
| Do | LT | Carigara, Leyte | 24001-24200 | 5 |
| Pacific Commercial Co | | Manila | 16001-16400 | 1 |
| Pardo y Robles Hermanos | NP | Naga, Camarines | 18201-18400 | 6 |
| Salustiano Zubeldia | SZ | Tabaco, Albay | 17901-18200 | 3 |
| Saturnino & Co | BS | Tigaon, Camarines | 26501-26600 | 5 |
| Siy Cong Bieng & Co | C/SCB | Sagnay, Camarines | 20901-21200 | 4 |
| Do | N/SCB | Naga, Camarines | 21201-21500 | 4 |
| Do | T/SCB | Tabaco, Albay | 26401-26500 | 4 |
| Do | D/SCB | Daet, Camarines | 25801-26000 | 5 |
| Siy Yoco & Co | SY | Tabaco, Albay | 11501-11900 | 4 |
| Smith, Bell & Co. (Ltd.) | | Manila | 8101-8700 | 1 |
| Do | | Cebu, Cebu | 8701-9300 | 1 |
| Do | | Legaspi, Albay | 9301-9800 | 2 |
| Do | | Tabaco, Albay | 9801-10300 | 1 |
| Do | | Virac, Catanduanes | 10301-10600 | 4 |
| Do | | Cagayan, Misamis | 10601-10900 | 5 |
| Do | | Lagonoy, Camarines | 20401-20700 | 6 |
| Tan Jong Yu | JY | Virac, Catanduanes | 10901-11100 | 4 |

| Name of establishment. | Press mark. | Grading section. | Lot number. | Class of establishment. |
|---|---|---|---|---|
| Tan Quion Quin & Co | TG | Casiguran, Sorsogon | 5901-6100 | 4 |
| Tan Senguan y Sobrinos | GS | Tacloban, Leyte | 22801-22900 | 4 |
| Do | TGS | Carigara, Leyte | 24201-24400 | 5 |
| Torribio Reyes Chua Yu | TRU | Cauit, Camarines | 14601-14800 | 6 |
| Ty Chuaco & Co | TC | Tabaco, Albay | 22301-22500 | 4 |
| U. de Poli | U de P | Manila | 27301-27500 | 4 |
| Urrutia & Co | | Daet, Camarines | 901-1100 | 6 |
| Vda. e Hijos de Chua Piengco | CP | Sorsogon, Sorsogon | 14801-15000 | 5 |
| Vda. e Hijos de F. Escaño | | Malitbog, Leyte | 15001-15200 | 4 |
| Vda. e Hijos de Josefa Pastrana & Co | HJP | Mauban, Tayabas | 19701-19900 | 6 |
| Vda. e Hijos de P. Aboitiz | | Palompon, Leyte | 19901-20100 | 4 |
| Vela Hermanos | VH | Iriga, Camarines | 24801-25000 | 6 |
| W. F. Stevenson & Co. (Ltd.) | | Manila | 6301-6800 | 1 |
| Do | | Cebu, Cebu | 6801-7300 | 1 |
| Warner, Barnes & Co. (Ltd.) | WB | Manila | 18401-18700 | 6 |
| Yap & Co | Y & C | Legaspi, Albay | 15601-15800 | 4 |
| Ynchausti & Co | | Sorsogon, Sorsogon | 7501-7800 | 3 |
| Do | | Gubat, Sorsogon | 7801-8000 | 4 |
| Yu Biao Sontua | HC | Surigao, Surigao | 1-399 | 4 |
| Do | YBS | Calbayog, Samar | 400-900 | 3 |
| Do | DOP | Tacloban, Leyte | 2601-3100 | 2 |
| Do | CB | Carigara, Leyte | 3301-3500 | 2 |

[a] P. O. From grades A to S3, and L. Y. from F to DM.

The following additional list gives the names of those grading establishments which have been discontinued since the fiber grading law went into effect:

*Discontinued Establishments.*

| Name of establishment. | Press mark. | Grading station. | Lot numbers. | Class of establishment. |
|---|---|---|---|---|
| A. T. Hoehener | BM | Calbayog, Samar | 20701-20900 | 5 |
| Ang Siliong | TT | Legaspi, Albay | 21901-22100 | 6 |
| Carlos Delgado | CD | Catarman, Samar | 18701-18900 | 6 |
| Chao Seng Ke | CSK | Laoang, Samar | 25601-25800 | 5 |
| E. Schulz & Co | | Manila | 11101-11300 | 6 |
| Gutierrez Hermanos | | Naga, Camarines | 2001-2200 | 6 |
| Juan Gorostiaga | | Coloncogon, Camarines | 17701-17900 | 5 |
| Manuel Oria Gonzales | LC | Laoang, Samar | 15401-15600 | 5 |
| Uy Gui Hian | UGH | Tabaco, Albay | 20101-20400 | 4 |
| Yap Tec Teng | | Legaspi, Albay | 19101-19300 | 4 |

Of the ninety-seven establishments operating under the fiber grading law, there are only twenty-six establishments that still use special house marks for each grade of the Government standard. The accompanying lists give the names of these establishments, together with the corresponding marks for each of the grades of abaca and maguey:

*Registered house marks.*

MAGUEY (CANTALA), RETTED.

| Grading establishment and stations. | MGY-1. | MGY-2. | MGY-3. | MGY-D. |
|---|---|---|---|---|
| Fernandez Hermanos, Manila. | FH/1 | FH/2 | FH/3 | FH/4 |
| Germann & Co. (Ltd.), Manila. | GER/M1 | GER/M2 | GER/M3 | |
| Ker & Co., Cebu | KC/M1 | KC/M2 | KC/M3 | KC/M4 |
| Ker & Co., Manila | M1 | M2 | M3 | M4 |
| Macleod & Co. (Inc.), Manila. | MC/M1 | MC/M2 | MC/M3 | MC/MD |
| Macleod & Co. (Inc.), Cebu. | PC/M1 | PC/M2 | PC/M3 | PC/MD |
| Pacific Commercial Company, Manila. | C/BW/MGY1 | C/BW/MGY2 | C/BW/MGY3 | C/BW/MGYD |
| Smith, Bell & Co., (Ltd.), Manila. | M/SW/MG1 | M/SW/MG2 | M/SW/MG3 | M/SW/MG/PP |
| Smith, Bell & Co. (Ltd.), Cebu. | SB/MG1 | SB/MG2 | SB/MG3 | SB/MG/PP |
| W. F. Stevenson & Co. (Ltd.), Manila | A1/MGY | B2/MGY | C3/MGY | D4/MGY |
| W. F. Stevenson & Co. (Ltd.), Cebu. | A1/SC | B2/SC | C3/SC | D4/SC |

The ninety-seven grading establishments were classified as follows: First class, 8; second class, 9; third class, 5; fourth class, 30; fifth class, 19; and sixth class, 26. The class of establishment is determined by the number of bales graded and baled per year. First-class establishments handle 40,000 bales or more; second class, 20,000 to 40,000; third class, 16,000 to 20,000; fourth class, 8,000 to 16,000; fifth class, 4,000 to 8,000; and sixth class, under 4,000 bales.

*Inspection stations.*—Fifteen inspectors were assigned to inspect fiber during the year, a gain of two inspectors over the previous year. These inspectors were assigned to the following stations: Manila, 6; Cebú, 2; Legaspi (including Ligao), 1; Tabaco, 1; Lagonoy district, 1; Sorsogon (including Casiguran and Gubat), 1; Calbayog, 1; Tacloban, 1; and Surigao, 1.

In order to exercise a closer supervision over the work of the various inspectors, four of the above inspectors were designated as supervising fiber inspectors, and each was given a district with powers to check and supervise the work of the inspectors stationed in that district.

One of the inspectors stationed at Manila is in charge of a general fiber-inspection office and his duty is to inspect, check, and stamp all fiber arriving at Manila from minor grading stations where no inspectors are assigned.

*Quantity of fiber graded and inspected.*—Accurate reports on the quantity of fiber graded, baled, inspected and certified to every month, by grades and provinces, were regularly prepared during the year as in the past year. These monthly reports were distributed to both local and foreign buyers and manufacturers, and our list of subscribers has been continually growing, which emphasizes the value of these reports to the trade in general.

The Government fiber inspectors, during the year 1916, inspected, stamped and approved 1,174,663 bales of abacá (Manila hemp) (see tables A and B), and 129,263 bales of retted maguey (see table C). This is an increase over the year 1915 of 163,297 bales of abacá (Manila hemp) and 69,323 bales of maguey. It is thus seen that the production of maguey during 1916 was more than double that of the previous year.

In addition to the above, there were inspected and approved 932 bales of retted sisal and 294 bales of pacol, making a grand total for the year of 1,305,152 bales of fiber against 1,071,983 bales for the year 1915, a gain of 233,169 bales.

During the year, the fiber inspectors rejected 36,302 bales of abacá, or about three per cent of the total production, on account of improper grading or packing, or because of the presence of weak or damaged fiber mixed in the normal grades. The larger portion of these rejected bales was regraded and rebaled, however, in conformity with the standard and regulations.

Tables A and C give in detail the number of bales of abacá and maguey inspected and approved during the year 1916, by provinces and by grades. These tables are a summary of the monthly reports which were published regularly during the year and distributed free of charge to all grading establishments in the Philippine Islands, and also to fiber buyers and manufacturers of the United States and Great Britain. Tables D to S give the production in bales by provinces and grades during the year 1916. Each table is followed by totals of production and percentages by grades for the same province during the year 1915, thus serving as a basis for comparison between the quantity as well as the quality of the production for the two years.

The year 1916 has been a very favorable year for the fiber industries, in so far as weather conditions are concerned. No typhoons nor floods of any serious character have visited the fiber provinces during the year, and the plantations in the southern Luzon provinces are reported to be fast recovering from the effects of the typhoons of 1915. This condition, it is

believed, is conducive to still further material increase in the production of abacá and maguey throughout the Archipelago.

TABLE A.—*Total production of abacá (Manila hemp) in bales by provinces and grades during the year 1916.*

| District of Production. | Standard grades. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | A. | B. | C. | D. | E. | S1. | S2. | S3. | F. | G. |
| Albay | 29 | 145 | 543 | 1,016 | 1,496 | 120 | 109 | 45 | 1,746 | 1,532 |
| Leyte | ------ | 2 | 147 | 2,940 | 20,862 | 3,423 | 7,910 | 3,366 | 45,559 | 14,107 |
| Camarines | 391 | 722 | 871 | 552 | 217 | 34 | 34 | 12 | 567 | 475 |
| Sorsogon | 3 | 94 | 225 | 333 | 2,164 | 62 | 171 | 47 | 10,119 | 5,546 |
| Samar | 5 | 51 | 852 | 4,295 | 16,257 | 5,281 | 14,215 | 4,693 | 33,923 | 16,036 |
| North Mindanao | 1 | 9 | 395 | 4,541 | 17,151 | 1,512 | 2,357 | 1,071 | 21,592 | 3,340 |
| South Mindanao | 568 | 2,768 | 7,561 | 8,566 | 9,595 | 1,880 | 1,141 | 274 | 10,036 | 826 |
| Cavite | 4,600 | 3,096 | 877 | 67 | 3 | 16 | 1 | ------ | ------ | ------ |
| Mindoro | 10 | 1,035 | 5,238 | 4,440 | 1,157 | 97 | 61 | 12 | 115 | 1 |
| Tayabas | ------ | 3 | 11 | 28 | 35 | 7 | 6 | ------ | 76 | 29 |
| Cebu | ------ | ------ | 40 | 1,325 | 4,163 | 1,511 | 220 | 25 | 1,744 | 162 |
| Various | 1,718 | 3,114 | 4,132 | 4,387 | 3,233 | 517 | 426 | 78 | 2,523 | 624 |
| Total | 7,325 | 11,039 | 20,892 | 32,490 | 76,333 | 14,460 | 26,651 | 9,623 | 128,000 | 42,678 |
| Percentage | 0.6 | 0.9 | 1.8 | 2.8 | 6.5 | 1.2 | 2.3 | 0.8 | 10.9 | 3.7 |

| District of Production. | Standard grades. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | H. | I. | J. | K. | L. | M. | DL. | DM. | O. Y. T. | Total. |
| Albay | 1,303 | 8,347 | 59,716 | 24,362 | 75,166 | 32,273 | 14,518 | 2,906 | 3,531 | 228,903 |
| Leyte | 12,123 | 47,220 | 69,008 | 27,505 | 30,892 | 2,415 | 337 | 9 | 12,432 | 300,257 |
| Camarines | 460 | 3,565 | 13,202 | 5,441 | 61,848 | 21,697 | 23,875 | 12,735 | 2,662 | 149,360 |
| Sorsogon | 8,061 | 33,434 | 50,808 | 18,648 | 5,403 | 383 | 3 | 2 | 2,072 | 137,578 |
| Samar | 2,749 | 22,257 | 4,118 | 681 | 168 | 92 | 6 | 15 | 2,698 | 128,392 |
| North Mindanao | 1,237 | 11,304 | 5,993 | 2,133 | 10,299 | 4,848 | 4,586 | 1,873 | 2,914 | 97,156 |
| South Mindanao | 161 | 3,702 | 480 | 134 | 56 | 11 | 3 | ------ | 822 | 48,584 |
| Cavite | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | 333 | 8,993 |
| Mindoro | ------ | 7 | ------ | ------ | ------ | ------ | ------ | ------ | 28 | 12,201 |
| Tayabas | ------ | 117 | 425 | 70 | 5,650 | 856 | 3,539 | 1,086 | 50 | 11,988 |
| Cebu | 45 | 372 | 171 | 13 | 4 | ------ | ------ | ------ | 127 | 9,922 |
| Various | 88 | 1,164 | 828 | 494 | 5,532 | 4,100 | 4,882 | 2,538 | 951 | 41,329 |
| Total | 26,227 | 131,489 | 204,749 | 79,481 | 195,018 | 66,675 | 51,749 | 21,164 | 28,620 | 1,174,663 |
| Percentage | 2.2 | 11.2 | 17.4 | 6.8 | 16.6 | 5.7 | 4.4 | 1.8 | 2.4 | 100 |

TABLE B.—*Comparative summary of production of abacá (Manila hemp) according to grade for the years 1915 and 1916.*

| Grades. | 1915. | | | | 1916. | | | |
|---|---|---|---|---|---|---|---|---|
| | Bales. | Percentage. | Bales. | Percentage. | Bales. | Percentage. | Bales. | Percentage. |
| Extra prime | 9,675 | 1.0 | | | 7,325 | 0.6 | | |
| Prime | 17,815 | 1.7 | | | 11,039 | 0.9 | | |
| Superior current | 34,323 | 3.4 | 61,816 | 6.1 | 20,892 | 1.8 | 39,256 | 3.3 |
| Good current | 57,161 | 5.6 | | | 32,490 | 2.8 | | |
| Midway | 115,600 | 11.4 | 172,761 | 17.0 | 76,333 | 6.5 | 108,823 | 9.3 |
| Streaky No. 1 | 21,335 | 2.1 | | | 14,460 | 1.2 | | |
| Streaky No. 2 | 23,271 | 2.3 | | | 26,651 | 2.3 | | |
| Streaky No. 3 | 8,976 | 0.9 | 53,582 | 5.3 | 9,623 | 0.8 | 50,734 | 4.3 |
| Current | 148,650 | 14.7 | | | 128,000 | 10.9 | | |
| Good fair | 110,132 | 10.9 | 258,782 | 25.6 | 131,489 | 11.2 | 259,489 | 22.1 |
| Seconds | 40,009 | 4.0 | | | 42,678 | 3.7 | | |
| Fair | 140,321 | 13.9 | 180,330 | 17.9 | 204,749 | 17.4 | 247,427 | 21.1 |
| Brown | 24,964 | 2.5 | | | 26,227 | 2.2 | | |
| Medium | 46,759 | 4.6 | 71,723 | 7.1 | 79,481 | 6.8 | 105,708 | 9.0 |
| Coarse and Daet coarse | 131,426 | 13.0 | 131,426 | 13.0 | 246,767 | 21.0 | 246,767 | 21.0 |
| Coarse brown and daet coarse brown | 65,592 | 6.5 | 65,592 | 6.5 | 87,839 | 7.5 | 87,839 | 7.5 |
| Strings, tow, and damaged | 15,324 | 1.5 | 15,324 | 1.5 | 28,620 | 2.4 | 28,620 | 2.4 |
| Total | | | 1,011,336 | 100 | | | 1,174,663 | 100 |

TABLE C.—*Production of maguey (cantala), retted, in the Philippine Islands, in bales, during the year 1916.*

| District of production. | Standard grades. | | | | |
|---|---|---|---|---|---|
| | MGY-1 | MGY-2 | MGY-3 | MGY-D | Total |
| Ilocos | 3,865 | 33,460 | 24,789 | 4,863 | 66,977 |
| Cebu | 5,972 | 33,591 | 16,659 | 1,546 | 57,768 |
| Bohol | 223 | 2,592 | 1,417 | 66 | 4,298 |
| Various | 5 | 140 | 65 | 10 | 220 |
| Total | 10,065 | 69,783 | 42,930 | 6,485 | 129,263 |
| Percentage | 7.8 | 54.0 | 33.2 | 5.0 | 100 |
| Totals and percentages for the year 1915 were as follows. | | | | | |
| Total | 3,162 | 32,497 | 21,035 | 3,246 | 59,940 |
| Percentage | 5.3 | 54.2 | 35.1 | 5.4 | 100 |

TABLE D.—*Production in bales of abacá in Albay Province during the year 1916.*

| Month. | A. | B. | C. | D. | E. | S1. | S2. | S3. | F. | G. | H. | I. | J. | K. | L. | M. | DL. | DM. | O.Y.T. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 8 | 106 | 270 | 272 | 250 | 11 | 14 | 2 | 158 | 100 | 150 | 712 | 6, 568 | 3, 404 | 7, 703 | 4, 365 | 64 | 22 | 338 | 24, 517 |
| February | 2 | 15 | 82 | 117 | 166 | 16 | 16 | 3 | 175 | 56 | 110 | 1, 074 | 7, 323 | 2, 716 | 8, 716 | 4, 698 | 24 | 25 | 383 | 25, 717 |
| March | 15 | 15 | 84 | 241 | 365 | 27 | 20 | 5 | 328 | 103 | 157 | 996 | 7, 589 | 2, 376 | 11, 373 | 4, 987 | 1, 086 | 278 | 402 | 30, 447 |
| April | | | 17 | 46 | 103 | 9 | 10 | 5 | 140 | 188 | 121 | 781 | 6, 198 | 1, 862 | 6, 919 | 2, 420 | 1, 422 | 251 | 332 | 20, 824 |
| May | 2 | 3 | 32 | 111 | 116 | 25 | 10 | 3 | 162 | 121 | 99 | 813 | 4, 004 | 1, 364 | 4, 067 | 1, 357 | 1, 361 | 291 | 301 | 14, 242 |
| June | | 2 | 34 | 139 | 270 | 12 | 11 | 9 | 283 | 65 | 79 | 602 | 3, 393 | 1, 387 | 7, 026 | 2, 526 | 800 | 202 | 264 | 17, 104 |
| July | | | 10 | 42 | 104 | 12 | 12 | 5 | 159 | 71 | 105 | 777 | 5, 529 | 2, 522 | 7, 260 | 2, 198 | 1, 569 | 209 | 410 | 20, 994 |
| August | 2 | 4 | 8 | 28 | 26 | 2 | 1 | | 33 | 209 | 111 | 769 | 4, 518 | 2, 048 | 4, 494 | 1, 219 | 789 | 117 | 224 | 14, 602 |
| September | | | 4 | 12 | 47 | 6 | 8 | 11 | 102 | 76 | 69 | 419 | 3, 709 | 1, 589 | 5, 618 | 2, 117 | 1, 588 | 278 | 269 | 15, 922 |
| October | | | | 1 | 7 | | 1 | | 33 | 104 | 58 | 353 | 3, 695 | 1, 704 | 4, 195 | 1, 736 | 1, 805 | 337 | 171 | 14, 200 |
| November | | | | | | | | | 18 | 52 | 71 | 248 | 1, 845 | 994 | 2, 361 | 1, 655 | 1, 597 | 328 | 153 | 9, 322 |
| December | | | 2 | 7 | 42 | | 6 | 2 | 155 | 387 | 173 | 803 | 5, 345 | 2, 396 | 5, 434 | 2, 995 | 2, 413 | 568 | 284 | 21, 012 |
| Total | 29 | 145 | 543 | 1, 016 | 1, 496 | 120 | 109 | 45 | 1, 746 | 1, 532 | 1, 303 | 8, 347 | 59, 716 | 24, 362 | 25, 166 | 32, 273 | 14, 518 | 2, 906 | 3, 531 | 228, 903 |
| Percentage | | 0. 1 | 0. 2 | 0. 4 | 0. 7 | 0. 1 | 0. 1 | | 0. 8 | 0. 7 | 0. 6 | 3. 6 | 26. 1 | 10. 6 | 32. 8 | 14. 1 | 6. 3 | 1. 3 | 1. 5 | 100 |
| Total production and percentages for the same province during 1915 were as follows: | | | | | | | | | | | | | | | | | | | | |
| Total | 847 | 1, 917 | 5, 590 | 6, 286 | 4, 466 | 358 | 165 | 116 | 11, 149 | 1, 803 | 2, 008 | 12, 610 | 61, 974 | 23, 654 | 70, 976 | 26, 013 | | | 3, 154 | 233, 086 |
| Percentage | 0. 4 | 0. 8 | 2. 4 | 2. 7 | 2. 0 | 0. 2 | 0. 1 | | 4. 8 | 0. 8 | 0. 8 | 5. 4 | 26. 6 | 10. 1 | 30. 5 | 11. 1 | | | 1. 3 | 100 |

TABLE E.—*Production in bales of abacá in Leyte Province during the year 1916.*

| Month. | A. | B. | C. | D. | E. | S1. | S2. | S3. | F. | G. | H. | I. | J. | K. | L. | M. | DL. | DM. | O.Y.T. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January |  |  | 34 | 514 | 1,957 | 515 | 509 | 226 | 2,720 | 1,578 | 944 | 3,711 | 3,522 | 1,163 | 12 |  |  |  | 659 | 18,064 |
| February |  |  | 1 | 142 | 914 | 197 | 280 | 122 | 1,822 | 1,305 | 1,006 | 3,761 | 5,191 | 1,750 | 79 |  |  |  | 696 | 17,273 |
| March |  |  | 7 | 351 | 2,028 | 454 | 754 | 342 | 3,817 | 1,237 | 857 | 4,121 | 4,690 | 1,494 | 248 | 7 |  |  | 1,223 | 21,638 |
| April |  | 1 | 28 | 519 | 3,023 | 544 | 880 | 218 | 4,485 | 1,192 | 1,009 | 3,908 | 5,988 | 1,941 | 1,125 | 15 |  |  | 1,346 | 26,250 |
| May |  |  | 25 | 251 | 1,895 | 329 | 812 | 379 | 4,287 | 1,345 | 1,384 | 5,002 | 6,149 | 1,889 | 1,285 | 43 |  |  | 1,267 | 26,378 |
| June |  |  | 7 | 239 | 1,829 | 342 | 968 | 344 | 4,685 | 1,370 | 1,168 | 4,245 | 5,576 | 2,257 | 3,814 | 79 |  |  | 1,120 | 28,091 |
| July |  |  | 22 | 114 | 1,252 | 202 | 701 | 350 | 3,767 | 1,224 | 1,262 | 4,368 | 8,197 | 3,500 | 5,137 | 127 |  |  | 1,180 | 31,424 |
| August |  | 1 | 3 | 122 | 1,403 | 158 | 714 | 255 | 4,149 | 1,311 | 1,221 | 4,337 | 8,018 | 3,008 | 2,219 | 148 | 1 |  | 873 | 27,924 |
| September |  |  | 6 | 170 | 1,490 | 282 | 616 | 312 | 3,584 | 1,207 | 981 | 3,675 | 5,217 | 1,424 | 1,280 | 131 |  |  | 666 | 20,975 |
| October |  |  | 5 | 193 | 2,223 | 129 | 632 | 220 | 4,164 | 710 | 716 | 3,208 | 6,224 | 2,288 | 3,622 | 65 | 15 | 1 | 1,247 | 25,923 |
| November |  |  | 5 | 171 | 1,823 | 163 | 619 | 378 | 5,123 | 2,020 | 986 | 4,044 | 6,498 | 3,855 | 6,596 | 326 | 59 | 3 | 860 | 32,776 |
| December |  |  | 4 | 154 | 1,025 | 108 | 425 | 220 | 2,956 | 608 | 589 | 2,840 | 3,738 | 2,936 | 5,475 | 901 | 262 | 5 | 1,295 | 23,541 |
| Total |  | 2 | 147 | 2,940 | 20,862 | 3,423 | 7,910 | 3,366 | 45,559 | 14,107 | 12,123 | 47,220 | 69,008 | 27,505 | 30,892 | 2,415 | 337 | 9 | 12,432 | 300,257 |
| Percentage |  |  |  | 1.0 | 7.0 | 1.1 | 2.7 | 1.1 | 15.2 | 4.7 | 4.0 | 15.7 | 23.0 | 9.2 | 10.3 | 0.8 | 0.1 |  | 4.1 | 100 |

Total production and percentages for the same province during 1915 were as follows:

| Month. | A. | B. | C. | D. | E. | S1. | S2. | S3. | F. | G. | H. | I. | J. | K. | L. | M. | DL. | DM. | O.Y.T. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 3 | 124 | 651 | 7,098 | 38,747 | 8,129 | 9,619 | 4,372 | 61,497 | 18,912 | 13,664 | 50,096 | 38,485 | 9,830 | 1,302 | 277 |  |  | 4,341 | 267,147 |
| Percentage |  |  | 0.2 | 2.7 | 14.5 | 3.0 | 3.6 | 1.6 | 23.0 | 7.1 | 5.1 | 18.8 | 14.4 | 3.7 | 0.5 | 0.1 |  |  | 1.7 | 100 |

TABLE F.—*Production in bales of abacá in Camarines Province during the year 1916.*

| Month. | A. | B. | C. | D. | E. | S1. | S2. | S3. | F. | G. | H. | I. | J. | K. | L. | M. | DL. | DM. | O.Y.T. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 45 | 156 | 196 | 153 | 77 | 10 | 8 | 2 | 234 | 109 | 89 | 555 | 1,164 | 550 | 5,075 | 2,473 | 960 | 870 | 298 | 13,024 |
| February | 95 | 91 | 106 | 61 | 30 | 10 | 4 | | 82 | 130 | 50 | 740 | 1,228 | 444 | 5,435 | 3,009 | 1,333 | 958 | 211 | 14,017 |
| March | 73 | 234 | 211 | 95 | 39 | 7 | 18 | 9 | 114 | 72 | 54 | 700 | 2,132 | 1,040 | 5,920 | 2,350 | 2,525 | 1,530 | 399 | 17,522 |
| April | 47 | 66 | 72 | 55 | 3 | | | | 11 | 20 | 73 | 231 | 1,431 | 479 | 5,756 | 1,718 | 2,725 | 1,532 | 451 | 14,670 |
| May | 38 | 63 | 115 | 93 | 29 | 1 | 2 | | 18 | 40 | 45 | 313 | 1,178 | 461 | 6,915 | 2,090 | 3,348 | 1,425 | 392 | 16,566 |
| June | 2 | 8 | 9 | 9 | 13 | 4 | 1 | 1 | 15 | 10 | 19 | 435 | 1,339 | 502 | 4,776 | 1,603 | 1,532 | 661 | 162 | 11,101 |
| July | 4 | 4 | 4 | 18 | | | | | 32 | 29 | 15 | 265 | 1,279 | 536 | 6,079 | 1,777 | 2,147 | 981 | 198 | 13,368 |
| August | | | | 11 | 5 | | | | 16 | 24 | 16 | 85 | 870 | 362 | 4,742 | 1,256 | 1,849 | 698 | 150 | 10,084 |
| September | | 6 | 40 | 6 | 3 | 2 | | | 10 | 9 | 6 | 49 | 741 | 323 | 4,615 | 1,299 | 1,615 | 698 | 75 | 9,497 |
| October | 3 | 22 | 84 | 25 | 2 | | | | 33 | 16 | 37 | 51 | 623 | 222 | 4,387 | 1,187 | 1,895 | 992 | 79 | 9,658 |
| November | 25 | 30 | 24 | 24 | 16 | | 1 | | 1 | 10 | 13 | 50 | 447 | 198 | 3,602 | 1,312 | 2,326 | 1,453 | 61 | 9,593 |
| December | 59 | 42 | 10 | 2 | | | | | 1 | 6 | 43 | 91 | 770 | 324 | 4,546 | 1,623 | 1,620 | 937 | 186 | 19,260 |
| Total | 391 | 722 | 871 | 552 | 217 | 34 | 34 | 12 | 567 | 475 | 460 | 3,565 | 13,202 | 5,441 | 61,848 | 21,697 | 23,875 | 12,735 | 2,662 | 149,360 |
| Percentage | 0.2 | 0.5 | 0.6 | 0.3 | 0.1 | | | | 0.3 | 0.3 | 0.3 | 2.4 | 9.2 | 3.6 | 41.4 | 14.5 | 16.0 | 8.5 | 1.8 | 100 |
| Total production and percentage for the same province during 1915 were as follows: | | | | | | | | | | | | | | | | | | | | |
| Total | 1,943 | 4,806 | 7,530 | 5,693 | 2,302 | 777 | 448 | 60 | 1,454 | 628 | 261 | 1,865 | 7,022 | 3,029 | 40,636 | 21,606 | | | 1,159 | 101,219 |
| Percentage | 1.9 | 4.8 | 7.4 | 5.6 | 2.3 | 0.8 | 0.4 | | 1.4 | 0.6 | 0.3 | 1.8 | 7.0 | 3.0 | 40.2 | 21.4 | | | 1.1 | 100 |

TABLE G.—*Production in bales of abacá in Sorsogon Province during the year 1916.*

| Month. | A. | B. | C. | D. | E. | S1. | S2. | S3. | F. | G. | H. | I. | J. | K. | L. | M. | DL. | DM. | O. Y. T. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | | 5 | 20 | 30 | 188 | 4 | 9 | 4 | 1,198 | 474 | 758 | 3,751 | 3,409 | 1,199 | 115 | 11 | | | 146 | 11,321 |
| February | | 2 | 3 | 5 | 114 | 3 | 5 | 4 | 893 | 661 | 848 | 2,909 | 4,278 | 2,058 | 317 | 13 | | | 364 | 12,477 |
| March | | 20 | 24 | 32 | 301 | 12 | 15 | 3 | 1,425 | 667 | 772 | 3,340 | 4,832 | 2,059 | 369 | 27 | | | 297 | 14,195 |
| April | 3 | 25 | 86 | 57 | 237 | 11 | 20 | 1 | 997 | 709 | 812 | 3,721 | 3,902 | 1,543 | 288 | 34 | | | 110 | 12,506 |
| May | | 4 | 22 | 69 | 263 | 6 | 36 | 4 | 614 | 586 | 764 | 2,995 | 4,289 | 1,523 | 468 | 25 | | | 176 | 12,044 |
| June | | | 8 | 28 | 189 | 9 | 25 | 7 | 698 | 330 | 469 | 2,435 | 3,744 | 1,417 | 277 | 29 | | 2 | 126 | 9,793 |
| July | | | | 6 | 105 | 1 | 5 | 1 | 612 | 223 | 435 | 1,999 | 4,283 | 1,604 | 369 | 10 | | | 210 | 9,863 |
| August | | 1 | 8 | 8 | 177 | 3 | | | 870 | 306 | 839 | 3,201 | 4,876 | 1,481 | 348 | 20 | | | 167 | 12,305 |
| September | | 1 | 13 | 25 | 290 | 3 | 20 | 7 | 897 | 354 | 595 | 2,703 | 4,867 | 1,721 | 790 | 55 | | | 204 | 12,545 |
| October | | 1 | 2 | 7 | 93 | | 7 | 3 | 491 | 280 | 399 | 1,664 | 3,581 | 1,237 | 813 | 81 | | | 63 | 8,722 |
| November | | 9 | 5 | 13 | 105 | 3 | 6 | 4 | 672 | 456 | 636 | 2,366 | 4,330 | 1,408 | 500 | 30 | | | 114 | 10,657 |
| December | | 26 | 84 | 53 | 102 | 7 | 23 | 9 | 552 | 500 | 734 | 2,350 | 4,417 | 1,398 | 749 | 48 | 3 | | 95 | 11,150 |
| Total | 3 | 94 | 225 | 333 | 2,164 | 62 | 171 | 47 | 10,119 | 5,546 | 8,061 | 33,434 | 50,808 | 18,648 | 5,403 | 383 | 3 | 2 | 2,072 | 137,578 |
| Percentage | | | 0.2 | 0.3 | 1.6 | | 0.1 | | 7.4 | 4.0 | 5.9 | 24.3 | 36.9 | 13.6 | 3.9 | 0.3 | | | 1,5 | 100 |
| Total production and percentages for the same province during 1915 were as follows: | | | | | | | | | | | | | | | | | | | | |
| Total | 79 | 1,923 | 4,155 | 5,704 | 10,223 | 721 | 883 | 191 | 20,013 | 7,908 | 6,805 | 29,863 | 25,868 | 4,569 | 2,193 | 386 | | | 1,890 | 123,374 |
| Percentage | 0.1 | 1.5 | 3.4 | 4.6 | 8.3 | 0.6 | 0.7 | 0.2 | 16.2 | 6.4 | 5.5 | 24.2 | 21.0 | 3.7 | 1.8 | 0.3 | | | 1.5 | 100 |

TABLE H.—*Production in bales of abacá in Samar Province during the year 1916.*

| Month. | A. | B. | C. | D. | E. | S1. | S2. | S3. | F. | G. | H. | I. | J. | K. | L. | M. | DL. | DM. | O. Y. T. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 1 | 7 | 94 | 427 | 1,323 | 503 | 861 | 239 | 2,092 | 510 | 54 | 496 | 52 | 14 | 1 | | | | 297 | 6,971 |
| February | 1 | 7 | 92 | 475 | 1,597 | 428 | 752 | 214 | 2,921 | 1,014 | 76 | 1,386 | 57 | 1 | | | | | 162 | 9,183 |
| March | 2 | 9 | 172 | 674 | 2,986 | 894 | 1,517 | 121 | 3,563 | 1,489 | 78 | 1,443 | 78 | 6 | | | | | 222 | 13,254 |
| April | | | 67 | 444 | 2,568 | 813 | 1,779 | 303 | 3,483 | 1,686 | 258 | 1,619 | 156 | 15 | 13 | 89 | 3 | 14 | 257 | 13,567 |
| May | | 5 | 188 | 833 | 1,851 | 633 | 1,853 | 529 | 3,782 | 2,155 | 365 | 2,396 | 133 | 80 | 1 | | 1 | | 297 | 15,102 |
| June | | | 18 | 221 | 965 | 293 | 1,166 | 383 | 2,562 | 1,383 | 275 | 1,818 | 222 | 5 | | | | | 217 | 9,528 |
| July | 1 | 2 | 36 | 288 | 1,419 | 636 | 2,105 | 590 | 4,025 | 1,750 | 321 | 2,720 | 365 | 73 | 2 | | | | 290 | 14,623 |
| August | | 10 | 55 | 253 | 716 | 272 | 1,177 | 456 | 2,237 | 1,168 | 182 | 1,776 | 294 | 41 | 8 | | | | 200 | 8,845 |
| September | | 5 | 44 | 237 | 930 | 287 | 1,172 | 506 | 2,845 | 1,290 | 273 | 2,006 | 723 | 93 | 14 | | | | 126 | 10,551 |
| October | | 2 | 17 | 123 | 678 | 151 | 701 | 504 | 2,559 | 1,268 | 317 | 2,624 | 706 | 102 | 68 | 3 | 2 | | 176 | 10,001 |
| November | | | 11 | 93 | 449 | 186 | 545 | 434 | 1,869 | 1,357 | 310 | 2,268 | 647 | 166 | 4 | | | 1 | 350 | 8,690 |
| December | | 4 | 58 | 227 | 775 | 185 | 587 | 414 | 1,985 | 966 | 240 | 1,705 | 685 | 85 | 57 | | | | 104 | 8,077 |
| Total | 5 | 51 | 852 | 4,295 | 16,257 | 5,281 | 14,215 | 4,693 | 33,923 | 16,036 | 2,749 | 22,257 | 4,118 | 681 | 168 | 92 | 6 | 15 | 2,698 | 128,392 |
| Percentage | | | 0.7 | 3.4 | 12.7 | 4.1 | 11.1 | 3.7 | 26.4 | 12.5 | 2.2 | 17.3 | 3.2 | 0.5 | 0.1 | | | | 2.1 | 100 |
| Totals of production and percentages for the same province during the year 1915 were as follows: | | | | | | | | | | | | | | | | | | | | |
| Total | 21 | 493 | 3,116 | 12,779 | 25,803 | 6,096 | 8,528 | 2,678 | 24,705 | 5,518 | 747 | 3,216 | 415 | 87 | 194 | 95 | | | 751 | 95,242 |
| Percentage | | 0.5 | 3.3 | 13.4 | 27.1 | 6.4 | 8.9 | 2.8 | 25.9 | 5.8 | 0.8 | 3.4 | 0.4 | 0.1 | 0.2 | 0.1 | | | 0.8 | 100 |

TABLE I.—*Production in bales of abacá in north Mindanao Provinces during the year 1916.*

| Month. | A. | B. | C. | D. | E. | S1. | S2. | S3. | F. | G. | H. | I. | J. | K. | L. | M. | DL. | DM. | O. Y. T. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | ------ | ------ | 44 | 321 | 1, 181 | 101 | 133 | 47 | 1, 049 | 133 | 59 | 542 | 277 | 101 | 215 | 90 | 43 | 7 | 113 | 4, 456 |
| February | ------ | ------ | 20 | 273 | 712 | 207 | 117 | 50 | 573 | 76 | 34 | 309 | 453 | 145 | 457 | 128 | 54 | 16 | 142 | 3, 766 |
| March | ------ | 1 | 72 | 519 | 1, 682 | 192 | 244 | 101 | 2, 176 | 310 | 161 | 990 | 306 | 123 | 347 | 183 | 31 | 47 | 222 | 7, 707 |
| April | ------ | 1 | 38 | 585 | 1, 719 | 144 | 149 | 101 | 1, 734 | 231 | 85 | 875 | 462 | 99 | 432 | 135 | 52 | 22 | 93 | 6, 957 |
| May | ------ | ------ | 42 | 606 | 2, 178 | 202 | 229 | 103 | 2, 519 | 296 | 103 | 992 | 684 | 222 | 1, 068 | 408 | 197 | 127 | 222 | 10, 198 |
| June | 1 | 2 | 21 | 240 | 1, 455 | 108 | 237 | 151 | 2, 514 | 390 | 142 | 1, 522 | 756 | 175 | 964 | 527 | 176 | 132 | 244 | 9, 757 |
| July | ------ | ------ | 16 | 266 | 1, 526 | 96 | 186 | 124 | 1, 644 | 299 | 220 | 792 | 420 | 151 | 1, 002 | 506 | 376 | 184 | 236 | 8, 044 |
| August | ------ | ------ | 3 | 215 | 1, 454 | 75 | 203 | 114 | 2, 323 | 362 | 179 | 1, 512 | 943 | 305 | 1, 133 | 622 | 498 | 104 | 446 | 10, 491 |
| September | ------ | ------ | 19 | 340 | 1, 458 | 152 | 246 | 78 | 2, 124 | 361 | 56 | 970 | 627 | 368 | 2, 319 | 796 | 1, 151 | 363 | 637 | 12, 065 |
| October | ------ | ------ | 5 | 134 | 809 | 44 | 112 | 36 | 1, 387 | 215 | 45 | 805 | 331 | 141 | 981 | 402 | 839 | 210 | 160 | 6, 656 |
| November | ------ | 2 | 34 | 356 | 1, 333 | 81 | 188 | 55 | 1, 782 | 250 | 49 | 843 | 209 | 130 | 728 | 585 | 408 | 231 | 151 | 7, 415 |
| December | ------ | 3 | 81 | 686 | 1, 644 | 110 | 313 | 111 | 1, 767 | 417 | 104 | 1, 152 | 525 | 173 | 653 | 466 | 761 | 430 | 248 | 9, 644 |
| Total | 1 | 9 | 395 | 4, 541 | 17, 151 | 1, 512 | 2. 357 | 1, 071 | 21, 592 | 3, 340 | 1, 237 | 11, 304 | 5, 993 | 2, 133 | 10, 299 | 4, 848 | 4, 586 | 1, 873 | 2, 914 | 97, 156 |
| Percentage | ------ | ------ | 0. 4 | 4. 7 | 17. 7 | 1. 6 | 2. 4 | 1. 1 | 22. 2 | 3. 4 | 1. 3 | 11. 6 | 6. 2 | 2. 2 | 10. 6 | 5. 0 | 4. 7 | 1. 9 | 3. 0 | 100 |
| Totals of production and percentages for the same provinces during the year 1915 were as follows: | | | | | | | | | | | | | | | | | | | | |
| Total | ------ | 34 | 621 | 5, 841 | 20, 451 | 2, 057 | 2, 551 | 1, 215 | 19, 668 | 3, 514 | 1, 102 | 9, 774 | 5, 534 | 4, 178 | 5, 396 | 9, 171 | ------- | ------- | 1, 833 | 92, 940 |
| Percentage | ------ | ------ | 0. 7 | 6. 2 | 22. 0 | 2. 2 | 2. 7 | 1. 3 | 21. 2 | 3. 8 | 1. 2 | 10. 5 | 6. 0 | 4. 5 | 5. 8 | 9. 9 | ------- | ------- | 2. 0 | 100 |

TABLE J.—*Production in bales of abacá in south Mindanao Provinces during the year 1916.*

| Month. | A. | B. | C. | D. | E. | S1. | S2. | S3. | F. | G. | H. | I. | J. | K. | L. | M. | DL. | DM. | O. Y. T. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 44 | 189 | 432 | 442 | 582 | 139 | 46 | 4 | 604 | 49 | 5 | 154 | ...... | ...... | ...... | ...... | ...... | ...... | 42 | 2, 732 |
| February | 23 | 173 | 361 | 377 | 503 | 88 | 13 | 1 | 447 | 35 | 2 | 111 | ...... | ...... | ...... | ...... | ...... | ...... | 65 | 2, 199 |
| March | 52 | 232 | 467 | 490 | 561 | 80 | 25 | 1 | 320 | 43 | 2 | 175 | 4 | ...... | ...... | ...... | ...... | ...... | 39 | 2, 491 |
| April | 24 | 206 | 458 | 449 | 675 | 86 | 28 | 6 | 805 | 71 | 6 | 412 | 83 | 5 | ...... | ...... | ...... | ...... | 46 | 3, 360 |
| May | 46 | 301 | 615 | 545 | 972 | 181 | 64 | 11 | 964 | 95 | 25 | 507 | 47 | 10 | 4 | ...... | ...... | ...... | 80 | 4, 467 |
| June | 38 | 172 | 506 | 763 | 1, 165 | 176 | 135 | 38 | 1, 127 | 72 | 17 | 354 | 1 | ...... | ...... | ...... | ...... | ...... | 70 | 4, 634 |
| July | 55 | 261 | 925 | 1, 025 | 994 | 222 | 98 | 21 | 970 | 57 | 15 | 360 | 3 | ...... | ...... | ...... | ...... | ...... | 55 | 5, 061 |
| August | 22 | 216 | 946 | 1, 029 | 799 | 192 | 174 | 33 | 1, 152 | 60 | 13 | 302 | ...... | ...... | ...... | ...... | ...... | ...... | 92 | 5, 030 |
| September | 40 | 155 | 605 | 980 | 836 | 161 | 141 | 38 | 785 | 57 | 22 | 256 | 4 | ...... | ...... | ...... | ...... | ...... | 59 | 4, 139 |
| October | 43 | 211 | 711 | 767 | 744 | 207 | 112 | 51 | 889 | 62 | 29 | 342 | 46 | ...... | ...... | ...... | ...... | ...... | 73 | 4, 287 |
| November | 93 | 345 | 829 | 968 | 1, 006 | 161 | 169 | 38 | 1, 056 | 139 | 11 | 432 | 59 | ...... | ...... | ...... | ...... | ...... | 116 | 5, 422 |
| December | 88 | 307 | 706 | 731 | 758 | 187 | 136 | 32 | 917 | 86 | 14 | 297 | 233 | 119 | 52 | 11 | 3 | ...... | 85 | 4. 762 |
| Total | 568 | 2, 768 | 7, 561 | 8, 566 | 9, 595 | 1, 880 | 1, 141 | 274 | 10, 036 | 826 | 161 | 3, 702 | 480 | 134 | 56 | 11 | 3 | ...... | 822 | 48, 584 |
| Percentage | 1.2 | 5.7 | 15.6 | 17.6 | 19.7 | 3.9 | 2.3 | 0.6 | 20.7 | 1.7 | 0.3 | 7.6 | 1.0 | 0.3 | 0.1 | ...... | ...... | ...... | 1.7 | 100 |

Totals of production and percentages for the same provinces during the year 1915 were as follows:

| Month. | A. | B. | C. | D. | E. | S1. | S2. | S3. | F. | G. | H. | I. | J. | K. | L. | M. | DL. | DM. | O. Y. T. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 827 | 2, 290 | 4, 938 | 5, 659 | 6, 616 | 1, 673 | 494 | 163 | 7, 383 | 1, 065 | 105 | 2, 210 | 213 | 1 | 53 | 39 | ...... | ...... | 591 | 34, 320 |
| Percentage | 2.4 | 6.7 | 14.7 | 16.5 | 19.3 | 4.9 | 1.4 | 0.5 | 21.5 | 3.1 | 0.3 | 6.4 | 0.6 | ...... | 0.1 | 0.1 | ...... | ...... | 1.6 | 100 |

TABLE K.—*Production in bales of abacá in Cavite Province during the year 1916.*

| Month. | A. | B. | C. | D. | E. | S1. | S2. | S3. | F. | G. | H. | I. | J. | K. | L. | M. | DL. | DM. | O. Y. T. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 448 | 285 | 31 | 3 | | 1 | | | | | | | | | | | | | 15 | 783 |
| February | 675 | 425 | 137 | | | | | | | | | | | | | | | | 31 | 1,268 |
| March | 617 | 456 | 52 | 2 | | | | | | | | | | | | | | | 21 | 1,148 |
| April | 360 | 264 | 35 | 2 | | | | | | | | | | | | | | | 8 | 669 |
| May | 346 | 259 | 77 | 6 | | | | | | | | | | | | | | | 28 | 716 |
| June | 194 | 234 | 47 | 11 | | 4 | | | | | | | | | | | | | 37 | 527 |
| July | 123 | 124 | 36 | 6 | | 11 | 1 | | | | | | | | | | | | 32 | 333 |
| August | 123 | 129 | 24 | | | | | | | | | | | | | | | | 17 | 293 |
| September | 284 | 244 | 70 | | | | | | | | | | | | | | | | 32 | 630 |
| October | 234 | 236 | 129 | 10 | | | | | | | | | | | | | | | 39 | 648 |
| November | 148 | 75 | 42 | 10 | | | | | | | | | | | | | | | 23 | 298 |
| December | 1,048 | 365 | 197 | 17 | 3 | | | | | | | | | | | | | | 50 | 1,680 |
| Total | 4,600 | 3,096 | 877 | 67 | 3 | 16 | 1 | | | | | | | | | | | | 333 | 8,993 |
| Percentage | 51.2 | 34.4 | 9.8 | 0.7 | | 0.2 | | | | | | | | | | | | | 3.7 | 100 |

Totals of production and percentages for the same province during the year 1915 were as follows:

| | A. | B. | C. | D. | E. | S1. | S2. | S3. | F. | G. | H. | I. | J. | K. | L. | M. | DL. | DM. | O. Y. T. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 5,165 | 4,215 | 1,576 | 109 | 27 | 27 | 1 | | | | | | | | | | | | 246 | 11,366 |
| Percentage | 45.4 | 37.1 | 13.9 | 1.0 | 0.2 | 0.2 | | | | | | | | | | | | | 2.2 | 100 |

TABLE L.—*Production in bales of abacá in Mindoro Province during the year 1916.*

| Month. | A. | B. | C. | D. | E. | S1. | S2. | S3. | F. | G. | H. | I. | J. | K. | L. | M. | DL. | DM. | O. Y. T. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January |  | 45 | 416 | 430 | 78 | 4 | 2 |  | 4 |  |  |  |  |  |  |  |  |  |  | 979 |
| February | 4 | 137 | 768 | 576 | 81 | 11 | 2 |  | 4 |  |  |  |  |  |  |  |  |  | 2 | 1,585 |
| March | 1 | 179 | 856 | 371 | 33 | 7 | 4 | 1 | 4 |  |  |  |  |  |  |  |  |  | 2 | 1,458 |
| April | 1 | 51 | 54 | 26 | 4 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  | 137 |
| May | 4 | 346 | 1,009 | 534 | 62 | 13 | 6 | 1 | 6 |  |  | 2 |  |  |  |  |  |  | 3 | 1,986 |
| June |  | 33 | 218 | 212 | 40 | 4 | 1 |  |  |  |  |  |  |  |  |  |  |  |  | 508 |
| July |  | 22 | 182 | 251 | 79 | 7 | 2 |  | 5 |  |  | 1 |  |  |  |  |  |  | 2 | 551 |
| August |  | 76 | 453 | 528 | 183 | 8 | 13 | 3 | 32 |  |  |  |  |  |  |  |  |  | 6 | 1,302 |
| September |  | 54 | 541 | 658 | 268 | 18 | 12 | 3 | 23 | 1 |  |  |  |  |  |  |  |  | 1 | 1,579 |
| October |  | 36 | 321 | 350 | 131 | 14 | 6 | 2 | 11 |  |  | 2 |  |  |  |  |  |  | 4 | 877 |
| November |  | 16 | 181 | 279 | 129 | 7 | 6 | 1 | 12 |  |  | 2 |  |  |  |  |  |  | 2 | 635 |
| December |  | 40 | 239 | 225 | 69 | 3 | 7 | 1 | 14 |  |  |  |  |  |  |  |  |  | 6 | 604 |
| Total | 10 | 1,035 | 5,238 | 4,440 | 1,157 | 97 | 61 | 12 | 115 | 1 |  | 7 |  |  |  |  |  |  | 28 | 12,201 |
| Percentage | 0.1 | 8.5 | 42.9 | 36.4 | 9.5 | 0.8 | 0.5 | 0.1 | 0.9 |  |  | 0.1 |  |  |  |  |  |  | 0.2 | 100 |
| Totals of production and percentages for the same province during the year 1915 were as follows: |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Total | 7 | 565 | 3,398 | 2,974 | 876 | 22 | 46 | 10 | 325 | 46 |  | 16 | 18 |  | 2 |  |  |  | 7 | 8,312 |
| Percentage |  | 6.8 | 40.9 | 35.8 | 10.5 | 0.3 | 0.6 | 0.1 | 3.9 | 0.6 |  | 0.2 | 0.2 |  |  |  |  |  |  | 100 |

TABLE M.—*Production in bales of abacá in Tayabas Province during the year 1916.*

| Month. | A. | B. | C. | D. | E. | S1. | S2. | S3. | F. | G. | H. | I. | J. | K. | L. | M. | DL. | DM. | O. Y. T. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | | | | | 1 | | | | 2 | | | | 24 | | 18 | 1 | 141 | 16 | | 198 |
| February | | | | | | | | | | | | 1 | 49 | 1 | 439 | 54 | 33 | 1 | 2 | 580 |
| March | | | | | | | | | 1 | | | | 33 | | 384 | 9 | 77 | 23 | 1 | 528 |
| April | | | | | | | | | 4 | 1 | | 5 | 28 | 2 | 796 | 119 | 366 | 159 | 1 | 1, 481 |
| May | | 3 | 10 | 16 | 16 | | | | 22 | 5 | | 28 | 68 | 9 | 1, 156 | 188 | 572 | 174 | 11 | 2, 278 |
| June | | | 1 | 4 | 9 | 5 | 4 | | 9 | 7 | | 13 | 61 | 13 | 636 | 118 | 188 | 53 | 5 | 1, 126 |
| July | | | | 1 | 1 | | | | 14 | | | 31 | 39 | 12 | 440 | 57 | 251 | 83 | 4 | 933 |
| August | | | | 1 | 2 | | | | 7 | 4 | | 12 | 34 | 6 | 542 | 67 | 335 | 105 | 2 | 1, 117 |
| September | | | | 5 | 4 | | | | 6 | 1 | | 7 | 46 | 14 | 385 | 55 | 419 | 141 | 14 | 1, 097 |
| October | | | | 1 | 2 | 2 | 2 | | 3 | 6 | | 5 | 13 | 3 | 408 | 66 | 503 | 145 | 4 | 1, 163 |
| November | | | | | | | | | 6 | 5 | | 12 | 20 | 6 | 284 | 53 | 353 | 87 | 1 | 827 |
| December | | | | | | | | | 2 | | | 3 | 10 | 4 | 167 | 69 | 301 | 99 | 5 | 660 |
| Total | | 3 | 11 | 28 | 35 | 7 | 6 | | 76 | 29 | | 117 | 425 | 70 | 5, 650 | 856 | 3, 539 | 1, 086 | 50 | 11, 988 |
| Percentage | | | | 0.2 | 0.3 | | | | 0.6 | 0.2 | | 1.0 | 3.5 | 0.6 | 47.1 | 7.1 | 30.0 | 9.0 | 0.4 | 100 |
| Totals of production and percentages for the same province during the year 1915 were as follows: | | | | | | | | | | | | | | | | | | | | |
| Total | | 286 | 1, 063 | 1, 393 | 842 | 15 | 6 | | 282 | 51 | | 11 | 88 | 4 | 4, 608 | 833 | | | 4 | 9, 486 |
| Percentage | | 3.0 | 11.2 | 14.7 | 8.9 | 0.2 | | | 3.0 | 0.5 | | 0.1 | 0.8 | | 48.7 | 8.9 | | | | 100 |

TABLE N.—*Production in bales of abacá in Cebu Province during the year 1916.*

| Month. | A. | B. | C. | D. | E. | S1. | S2. | S3. | F. | G. | H. | I. | J. | K. | L. | M. | DL. | DM. | O. Y. T. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | | | 6 | 122 | 168 | 64 | 12 | 5 | 27 | 14 | 3 | 12 | 1 | 1 | | | | | 20 | 455 |
| February | | | 7 | 84 | 217 | 97 | 6 | | 36 | 1 | 1 | 5 | 1 | | | | | | 4 | 459 |
| March | | | | 45 | 171 | 54 | 8 | | 81 | | | 2 | | | | | | | 1 | 362 |
| April | | | 3 | 58 | 203 | 96 | 18 | 6 | 68 | 40 | 14 | 48 | 34 | 1 | 1 | | | | 32 | 622 |
| May | | | 7 | 247 | 586 | 187 | 25 | 3 | 127 | 22 | 6 | 28 | 9 | 2 | | | | | 6 | 1,255 |
| June | | | 1 | 44 | 216 | 88 | 27 | 6 | 111 | 37 | 8 | 44 | 19 | | | | | | 32 | 633 |
| July | | | 9 | 257 | 690 | 269 | 30 | 3 | 206 | 15 | 4 | 38 | 25 | 3 | | | | | 6 | 1,555 |
| August | | | 1 | 214 | 460 | 186 | 26 | 2 | 260 | 9 | 1 | 38 | 13 | | 1 | | | | 7 | 1,218 |
| September | | | 4 | 127 | 555 | 169 | 13 | | 251 | 4 | 1 | 43 | 16 | 5 | 1 | | | | 5 | 1,184 |
| October | | | 1 | 62 | 335 | 91 | 11 | | 155 | 6 | 3 | 42 | 23 | | | | | | 5 | 734 |
| November | | | 1 | 38 | 234 | 93 | 13 | | 116 | 8 | 4 | 37 | 26 | 1 | 1 | | | | 4 | 576 |
| December | | | | 27 | 328 | 127 | 31 | | 306 | 6 | | 35 | 4 | | | | | | 5 | 869 |
| Total | | | 40 | 1,325 | 4,163 | 1,511 | 220 | 25 | 1,744 | 162 | 45 | 372 | 171 | 13 | 4 | | | | 127 | 9,922 |
| Percentage | | | 0.4 | 13.4 | 42.0 | 15.2 | 2.2 | 0.3 | 17.6 | 1.6 | 0.5 | 3.7 | 1.7 | 0.1 | | | | | 1.3 | 100 |

Totals of production and percentages for the same province during the year 1915 were as follows:

| | A. | B. | C. | D. | E. | S1. | S2. | S3. | F. | G. | H. | I. | J. | K. | L. | M. | DL. | DM. | O. Y. T. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | | 17 | 143 | 1,447 | 3,183 | 1,227 | 309 | 123 | 977 | 261 | 161 | 221 | 147 | 285 | 209 | 450 | | | 611 | 9,771 |
| Percentage | | 0.2 | 1.5 | 14.8 | 32.6 | 12.6 | 3.1 | 1.3 | 10.0 | 2.6 | 1.7 | 2.3 | 1.5 | 2.9 | 2.1 | 4.6 | | | 6.2 | 100 |

TABLE O.—*Production in bales of abacá in various provinces during the 1916.*

| Month. | A. | B. | C. | D. | E. | S1. | S2. | S3. | F. | G. | H. | I. | J. | K. | L. | M. | DL. | DM. | O. Y. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 145 | 83 | 90 | 153 | 152 | 45 | 10 | 2 | 63 | 10 | 1 | 12 | 31 | 22 | 264 | 162 | 66 | 6 | 42 | 1,359 |
| February | 128 | 89 | 221 | 364 | 320 | 40 | 24 | 1 | 195 | 25 | ------ | 48 | 47 | 106 | 598 | 472 | 356 | 66 | 99 | 3,199 |
| March | 147 | 97 | 141 | 223 | 184 | 27 | 16 | 2 | 133 | 27 | 1 | 43 | 72 | 45 | 721 | 470 | 131 | 147 | 74 | 2,701 |
| April | 83 | 62 | 172 | 191 | 117 | 31 | 13 | 1 | 86 | 33 | 6 | 55 | 39 | 6 | 427 | 167 | 108 | 39 | 14 | 1,650 |
| May | 214 | 284 | 425 | 464 | 292 | 57 | 31 | 6 | 271 | 50 | 8 | 105 | 66 | 65 | 1,038 | 562 | 564 | 132 | 98 | 4,732 |
| June | 83 | 308 | 421 | 346 | 225 | 43 | 29 | 5 | 210 | 31 | 6 | 59 | 52 | 62 | 1,030 | 573 | 539 | 151 | 76 | 4,249 |
| July | 150 | 243 | 387 | 590 | 467 | 68 | 83 | 8 | 412 | 98 | 13 | 265 | 131 | 54 | 470 | 371 | 629 | 181 | 157 | 4,777 |
| August | 107 | 291 | 466 | 562 | 397 | 55 | 47 | 6 | 258 | 71 | 4 | 78 | 58 | 23 | 189 | 263 | 295 | 229 | 61 | 3,460 |
| September | 176 | 305 | 352 | 382 | 404 | 47 | 53 | 17 | 341 | 132 | 22 | 203 | 149 | 54 | 422 | 554 | 820 | 522 | 97 | 5,052 |
| October | 148 | 303 | 473 | 385 | 232 | 36 | 43 | 12 | 187 | 31 | 4 | 102 | 62 | 24 | 222 | 219 | 610 | 242 | 51 | 3,386 |
| November | 143 | 328 | 326 | 301 | 203 | 33 | 44 | 8 | 190 | 68 | 12 | 86 | 49 | 16 | 126 | 239 | 539 | 410 | 104 | 3,225 |
| December | 194 | 721 | 658 | 426 | 240 | 35 | 33 | 10 | 177 | 48 | 11 | 108 | 72 | 17 | 25 | 48 | 225 | 413 | 78 | 3,539 |
| Total | 1,718 | 3,114 | 4,132 | 4,387 | 3,233 | 517 | 426 | 78 | 2,523 | 624 | 88 | 1,164 | 828 | 494 | 5,532 | 4,100 | 4,882 | 2,538 | 951 | 41,329 |
| Percentage | 4.2 | 7.5 | 10.0 | 10.6 | 7.8 | 1.3 | 1.0 | 0.2 | 6.1 | 1.5 | 0.2 | 2.8 | 2.0 | 1.2 | 13.4 | 9.9 | 11.8 | 6.2 | 2.3 | 100 |

Totals of production and percentages for the same provinces during the year 1915 were as follows:

| | A. | B. | C. | D. | E. | S1. | S2. | S3. | F. | G. | H. | I. | J. | K. | L. | M. | DL. | DM. | O. Y. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 786 | 1,145 | 1,542 | 2,178 | 2,064 | 233 | 221 | 48 | 1,197 | 303 | 111 | 250 | 557 | 1,122 | 5,857 | 6,722 | ------ | ------ | 737 | 25,073 |
| Percentage | 3.1 | 4.6 | 6.1 | 8.7 | 8.2 | 0.9 | 0.9 | 0.1 | 4.8 | 1.2 | 0.5 | 1.0 | 2.2 | 4.4 | 23.4 | 26.8 | ------ | ------ | 3.1 | 100 |

TABLE P.—*Production of maguey (cantala), retted, in Ilocos Provinces during the year 1916.*

| Month. | MGY-1. | MGY-2. | MGY-3. | MGY-D. | O. T. | Total. |
|---|---|---|---|---|---|---|
| January | 348 | 1,460 | 762 | 120 | ---------- | 2,690 |
| February | 320 | 2,010 | 1,298 | 194 | ---------- | 3,822 |
| March | 860 | 6,306 | 2,235 | 342 | ---------- | 10,743 |
| April | 543 | 3,034 | 1,260 | 299 | ---------- | 5,136 |
| May | 850 | 7,955 | 5,706 | 716 | ---------- | 15,227 |
| June | 576 | 4,186 | 3,152 | 381 | ---------- | 8,295 |
| July | 193 | 1,750 | 1,534 | 542 | ---------- | 4,019 |
| August | 29 | 312 | 797 | 307 | ---------- | 1,445 |
| September | 30 | 1,325 | 1,232 | 465 | ---------- | 3,052 |
| October | 18 | 1,420 | 1,575 | 314 | ---------- | 3,327 |
| November | 17 | 808 | 1,699 | 511 | ---------- | 3,035 |
| December | 81 | 2,864 | 2,539 | 672 | ---------- | 6,186 |
| Total | 3,865 | 33,460 | 24,789 | 4,863 | ---------- | 66,977 |
| Percentage | 5.8 | 49.9 | 37.0 | 7.3 | ---------- | 100 |
| Totals of production and percentages for the same provinces during the year 1915 were as follows: | | | | | | |
| Total | 1,175 | 16,069 | 7,257 | 2,309 | 14 | 26,824 |
| Percentage | 4.4 | 59.9 | 27.1 | 8.6 | ---------- | 100 |

TABLE Q.—*Production of maguey (cantala), retted, in Cebu Province during the year 1916.*

| Month. | MGY-1. | MGY-2. | MGY-3. | MGY-D. | Total. |
|---|---|---|---|---|---|
| January | 619 | 2,475 | 695 | 57 | 3,846 |
| February | 516 | 3,417 | 1,627 | 133 | 5,693 |
| March | 361 | 1,672 | 1,036 | 47 | 3,116 |
| April | 444 | 2,207 | 1,598 | 141 | 4,390 |
| May | 457 | 3,119 | 2,276 | 226 | 6,078 |
| June | 210 | 2,116 | 1,765 | 160 | 4,251 |
| July | 493 | 3,279 | 1,800 | 189 | 5,761 |
| August | 429 | 3,368 | 1,488 | 187 | 5,472 |
| September | 615 | 3,240 | 1,295 | 164 | 5,314 |
| October | 572 | 3,029 | 951 | 71 | 4,623 |
| November | 645 | 2,820 | 1,107 | 91 | 4,663 |
| December | 611 | 2,849 | 1,021 | 80 | 3,561 |
| Total | 5,972 | 33,591 | 16,659 | 1,546 | 54,768 |
| Percentage | 10.3 | 58.3 | 28.8 | 2.6 | 100 |
| Totals of production and percentages for the same province during the year 1915 were as follows: | | | | | |
| Total | 1,951 | 15,642 | 13,065 | 865 | 31,523 |
| Percentage | 6.2 | 49.6 | 41.4 | 2.8 | 100 |

TABLE R.—*Production of maguey (cantala), retted, in Bohol Province during the year 1916.*

| Month. | MGY-1. | MGY-2. | MGY-3. | MGY-D. | Total. |
|---|---|---|---|---|---|
| January | 3 | 66 | 31 | 7 | 107 |
| February | 25 | 376 | 240 | 18 | 659 |
| March | 41 | 319 | 144 | 4 | 508 |
| April | | | | | |
| May | 14 | 355 | 178 | 5 | 552 |
| June | 27 | 264 | 124 | 6 | 421 |
| July | 42 | 343 | 163 | 6 | 554 |
| August | 6 | 246 | 185 | 9 | 446 |
| September | 15 | 179 | 123 | 3 | 320 |
| October | 19 | 222 | 130 | 2 | 373 |
| November | 12 | 65 | 23 | 1 | 101 |
| December | 19 | 157 | 76 | 5 | 257 |
| Total | 223 | 2,592 | 1,417 | 66 | 4,298 |
| Totals of production and percentages for the same province during the year 1915 were as follows: | | | | | |
| Total | 20 | 493 | 478 | 41 | 1,032 |
| Percentage | 1.9 | 47.8 | 46.3 | 4.0 | 100 |

TABLE S.—*Production of maguey (cantala), retted, in various provinces during the year 1916.*

| Month. | MGY-1. | MGY-2. | MGY-3. | MGY-D. | Total. |
|---|---|---|---|---|---|
| January | | | | | |
| February | | 8 | 3 | 1 | 12 |
| March | | | | | |
| April | 3 | 74 | 46 | 8 | 131 |
| May | | 6 | 3 | | 9 |
| June | | | | | |
| July | 1 | 9 | 1 | | 11 |
| August | 1 | 4 | 1 | 1 | 7 |
| September | | 26 | 8 | | 34 |
| October | | 13 | 3 | | 16 |
| November | | | | | |
| December | | | | | |
| Total | 5 | 140 | 65 | 10 | 220 |
| Percentage | 2.3 | 63.6 | 29.6 | 4.5 | 100 |
| Totals of production and percentages for the same provinces during the year 1915 were as follows: | | | | | |
| Total | 16 | 293 | 235 | 17 | 561 |
| Percentage | 2.9 | 52.2 | 41.9 | 3.0 | 100 |

*Exports of fiber to foreign countries.*—In addition to the preceding data regarding the production of fiber by provinces and grades, there are given below statistics concerning the export of abaca and maguey from the Philippine Islands by grades and countries of destination. These statistics were compiled from a statement prepared by the Bureau of Customs and therefore constitute the most complete and reliable information on the subject.

*Shipment of fiber from the Philippines by grades and cauntries of destination during the year 1916.*

1. ABACA (MANILA HEMP).

| Grades. | United States and Canada. | | United Kingdom. | | Europe (Continental.) | | Japan. | | Australasia. | | All other. | | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bales. | Per-cent. | Bales. | Per-cent. | Bales. | Per-cent. | Bales. | Per-cent. | Bales. | Per-cent. | Bales. | Per-cent. | |
| A. Extra prime | 278 | 3.7 | 6 | 0.1 | 13 | 0.2 | 7,220 | 96.0 | | | | | 7,517 |
| B. Prime | 2,825 | 24.8 | 244 | 2.1 | 48 | 0.4 | 8,291 | 72.7 | | | | | 11,408 |
| C. Superior current | 9,738 | 42.9 | 3,011 | 13.3 | 195 | 0.9 | 9,563 | 42.2 | 40 | 0.2 | 108 | 0.5 | 22,655 |
| D. Good current | 20,245 | 56.3 | 4,818 | 13.4 | 630 | 1.8 | 6,807 | 18.9 | 759 | 2.1 | 2,679 | 7.5 | 35,938 |
| E. Midway | 73,278 | 88.7 | 1,467 | 1.8 | 507 | 0.6 | 2,861 | 3.4 | 4,387 | 5.3 | 143 | 0.2 | 82,643 |
| S1. Streaky one | 18,408 | 96.5 | 202 | 1.1 | 212 | 1.1 | 254 | 1.3 | | | 1 | | 19,077 |
| S2. Streaky two | 13,990 | 59.6 | 5,685 | 24.1 | 85 | 0.4 | 3,725 | 15.9 | | | 6 | | 23,491 |
| S3. Streaky three | 3,370 | 39.5 | 4,435 | 52.0 | 3 | | 719 | 8.4 | | | 5 | 0.1 | 8,532 |
| F. Current | 124,306 | 93.9 | 2,226 | 1.6 | 240 | 0.2 | 938 | 0.7 | 4,462 | 3.4 | 205 | 0.2 | 132,377 |
| G. Seconds | 28,100 | 60.8 | 14,414 | 31.3 | 517 | 1.1 | 1,202 | 2.6 | 1,955 | 4.2 | 1 | | 46,187 |
| H. Brown | 9,830 | 39.2 | 15,133 | 60.3 | 8 | | 24 | 0.1 | 101 | 0.4 | 5 | | 25,101 |
| L. Good fair | 129,198 | 94.3 | 4,812 | 3.5 | 228 | 0.2 | 233 | 0.2 | 1,970 | 1.4 | 516 | 0.4 | 136,957 |
| J. Fair | 93,555 | 51.2 | 67,545 | 37.0 | 1,448 | 0.8 | 1,434 | 0.8 | 5,010 | 2.7 | 13,662 | 7.5 | 182,654 |
| K. Medium | 8,443 | 14.1 | 48,624 | 81.1 | 578 | 1.0 | 92 | 0.2 | 1,814 | 3.0 | 366 | 0.6 | 59,917 |
| L. Coarse | 7,031 | 4.2 | 136,644 | 82.3 | 8,117 | 4.9 | 1,783 | 1.1 | 1,124 | 0.7 | 11,306 | 6.8 | 166,005 |
| M. Coarse Brown | 961 | 1.4 | 60,598 | 89.1 | 2,829 | 4.2 | 105 | 0.2 | | | 3,391 | 5.0 | 67,884 |
| DL. Daet coarse | | | 26,581 | 95.6 | 1,220 | 4.4 | | | | | 4 | | 27,805 |
| DM. Daet coarse brown | | | 11,171 | 95.6 | 516 | 4.4 | | | | | | | 11,687 |
| O. Y. T. Strings and tow | 8,856 | 31.1 | 2,859 | 10.1 | 113 | 0.4 | 16,494 | 58.0 | | | 101 | 0.4 | 28,423 |
| Total | 552,413 | | 410,475 | | 17,507 | | 61,745 | | 21,622 | | 32,499 | | 1,096,260 |

2. *Maguey—Retted.*

| Grades. | United States and Canada. | | United Kingdom. | | Europe (continental.) | | Japan. | | All others. | | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bales. | Per-cent. | Bales. | Per-cent. | Bales. | Per-cent. | Bales. | Per-cent. | Bales. | Per-cent. | |
| Maguey 1 | 7,798 | 74.2 | 1,937 | 18.5 | 70 | 0.7 | 545 | 5.2 | 148 | 1.4 | 10,498 |
| Maguey 2 | 48,153 | 66.9 | 16,311 | 22.7 | 2,433 | 3.4 | 5,059 | 7.0 | 32 | ...... | 71,988 |
| Maguey 3 | 18,495 | 50.2 | 13,562 | 36.8 | 281 | 0.8 | 4,449 | 12.1 | 22 | 0.1 | 36,809 |
| Maguey D | 101 | 1.8 | 1,113 | 20.1 | ........ | ...... | 4,323 | 78.1 | 5 | ...... | 5,542 |
| Total | 74,547 | ...... | 32,923 | ...... | 2,784 | ...... | 14,376 | ...... | 207 | ...... | 124,837 |

*Quality of fiber.*—The general quality of abacá during the year has unfortunately declined considerably. This decline, while affecting most of the grades in which the fiber is of excellent or of good cleaning, has been more evident in the grades Superior current, Good current, Midway, and Current. The relative production of the Streaky grades during the year was very much the same as in the previous year, with the exception of a slight decline in the grade Streaky No. 1. The relative as well as the actual production of all grades in which the fiber is of fair or coarse cleaning has shown a considerable increase over the past year. In other words, the decline occurred in the so-called U. S. grades, with the exception of the lowest two grades, namely, Good fair and Fair; while the increase was almost entirely evident in the so-called U. K. grades. (See Table B.)

There are two reasons for this unfortunate decline in the production of the higher grades of abacá, both of which are beyond the control of the Government. First, the damaging effects of the typhoons and floods which hit the principal abacá-producing provinces during the last quarter of the year 1915. Strong winds cause a large number of stalks, both mature and immature, to fall to the ground. The number of such stalks is usually so large as to require several days, and in some instances several weeks, before the laborers can strip the fiber in them, with the consequence that a large number are half deteriorated and partially fermented before they are stripped. Such stalks cannot be so cleaned as to produce good-grade fiber, and the producers are forced to lessen the tension on their knives or substitute knives with wider serrations, thus producing a strippy fiber or a fiber with an inferior dingy color. The rains and floods also interfere seriously with the proper drying and bleaching of the fiber. Second, the aforementioned typhoons having struck two of the provinces which normally produce the bulk of the coarse and strippy fiber, there arose in the market the fear

that during 1916 there would occur a serious shortage in the supply of abacá, chiefly in the U. K. grades. As a result of this fear, the prices for these grades advanced considerably during the first half of 1916, while the prices of the better grades either remained stationary or advanced slightly. This sudden and considerable advance in the prices of the lower grades was, in the opinion of the writer, the primary cause of the increased production of these grades during the year.

During the last quarter of 1916 when the serious shortage in the production of the higher grades, especially Midway and Current, became increasingly evident, the situation in regard to prices was almost completely reversed, and indications pointing to a larger production of high grades during 1917 are already evident.

The quality of retted maguey during the year continued to be on the whole satisfactory, showing a slightly higher percentage of grade No. 1, and a corresponding reduction in grades No. 3 and Damaged. The relative production of grade No. 2 remained practically the same as in the previous year, constituting about 54 per cent of the total. (See Table C).

## BOOK REVIEW.

### SULPHITATION IN WHITE SUGAR MANUFACTURE.

By FRANCES MAXWELL, Ph. D., A. M. I. Mech. E., T. C. S.

REVIEWED by CLEVE W. HINES, Sugar Technologist.

There has been a growing demand for a treatise on the subject of sulphitation in the sugar factory due to the importance given to the increased production of white sugar directly from the plantation factory, and this well written and very complete book is an important addition to the technical works on sugar manufacture.

It was prepared by a man of long experience in the sugar industry and deals with the subject in a practical manner, and offers as well very thorough explanations of the various theoretical problems involved. While the book is small, containing only seventy-two pages, it is very complete and leaves few important questions on this subject untouched.

The book is divided into ten chapters, as follows:

CHAPTER I. Origin, preparation, and properties of sulphur.
II. Sulphurous acid, its preparation, chemical properties, and action.
III. Generating of sulphur dioxide and its application to juice and sirup.
IV. Control of the generating plant.
V. Analysis of sulphurous acid.
VI. Action of sulphurous acid on juices.
VII. Principles of application of sulphurous acid.
VIII. Sulphitation of sirup and molasses.
IX. Sulphitation process in practice.
X. Processes applied by leading white-sugar factories.

This book may be obtained from Norman Roger, 2 St. Dunstan's Hill, London, England, Price 7s. 10d.

# CURRENT NOTES—FIRST QUARTER.

NOTES BY P. J. WESTER, Horticulturist in charge of Lamao Experiment Station.

## NOTES ON THE PANAMA-HAT PALM.

The successful introduction of this palm, *Carludovica palmata*, into the Philippines has been mentioned by Mr. M. M. Saleeby, chief, fiber division, in a previous issue of this REVIEW.

This plant is not, as the name implies, a palm, but a stemless endogen belonging to the *Cyclanthaceae,* attaining a height of 1 to 2 meters, with long, slender petioles, and large, palmate leaves.

The panama-hat palm should be grown at low elevations in those regions where the rainfall is abundant and equally distributed throughout the year. It should be planted in partial shade, in fertile, friable, loamy soil which is rich in humus and moist but well drained. Heavy clay soils are unsuited to this plant.

The young plants should be set out in rows 2.5 to 3 meters apart, and planted 1½ to 2 meters apart in the row, or at the rate of not less than 1,666 plants per hectare.

Preparatory to setting the plants in the field, the field should be thoroughly cleared of all native vegetation, particularly noxious weeds such as cogon, and plowed and harrowed.

The panama-hat palm is readily multiplied by division of the old plants. The plant is so easily propagated that there is no need to perform this in the nursery as the divided plants may be set directly in the field. In doing so, after the field is prepared and staked ready for planting, about three-fourths of the leaf blades of the plant that is to be divided should be trimmed off, then the soil should be dug away around the plant and with a sharp spade or a bolo the clump should be divided into smaller ones, preferably so that there are two or three "hearts" to a clump. These plants should be planted carefully at the same depth as they grew before division took place, and the work should be performed during the rainy season.

No experiments seem to have been made to discover which

plants are the best for shade, but it is probable that the ipil-ipil, *Leucaena glauca,* which is used so successfully in shading coffee, would also make a good shade tree for the panama-hat palm. Planted 5 meters apart in each alternate middle, or 5 by 6 meters, 333 plants to the hectare, the ipil-ipil would in all likelihood furnish the necessary shade.

Planted at the distances indicated the full-grown plants will effectually shade the ground and after they are well established will keep the weeds in check, but until then the field should be cultivated from time to time to keep the weeds down. During this period cadios, *Cajanus indicus* Spreng., is suggested as a good intercrop, for the temporary protection it would give the plants, as an aid in controlling the weeds, and to enrich the ground.

### FORAGE PLANTS OF POSSIBLE VALUE FOR THE PHILIPPINES.

In 1911 the Florida beggar weed, *Desmodium tortuosum,* and Natal grass, *Thysalonaea rosea,* were introduced into the Philippines and seed was sown at the Lamao experiment station. While both made a fairly satisfactory growth other forage plants were considered superior and no further trials were made. The two plants practically disappeared from the field until in 1916 when large numbers of volunteer plants sprang up, this evidently being a case of the "survival of the fittest." Seeds are now being saved of both species for continued breeding work.

### "THE MANGOS OF CUBA."

This is the name of an interesting paper read by Wilson Popenoe, before the American Pomological Society in September, 1915, and recently published in the proceeding of that society. In this paper Mr. Popenoe classifies the Cuban mangos into three general races, Mango, Manga, and Filipino; the race Mango is again divided into two types, Manga amarilla and Manga blanca. In addition to these there are several other important and as yet unclassified forms.

According to Philippine standards the Cuban mangos are very inferior fruits, the Filipino mango excepted. This is a long, slender mango of excellent flavor and quality which is also found in Mexico, where it is known as the Manila mango, and it is without question of Philippine origin. In flavor and quality the Filipino mango of Cuba has much in common with the Carabao mango in this Archipelago, but it is longer, flatter, and more slender than the Carabao, to which it is also somewhat inferior in size.

## IMPROVING THE PAPAW.

Were it not for the papaw, *Asimina triloba* Dunal, the Tropics would have a monopoly of all the annonaceous fruits. The papaw is a handsome, small tree native of the United States, where it ranges from Florida to New York, and westward to Oklahoma and the Gulf of Mexico.

The papaw has much in common with the annonaceous fruits, with which residents in the Tropics are familiar, in respect to texture, aroma and flavor and rather poor keeping qualities; the fruits, which resemble the fruits of the *Uvarias* rather than those of the *Annonas*, are seedy, and average about 225 grams in weight. The American Genetic Association has now interested itself in the improvement of the papaw and has offered a reward of $50 for the largest tree and $50 for the tree that bears the best fruit.[1]

It is stated that "grafting in the spring has been found to offer no great obstacle, and is the best means of propagation from the plant breeders point of view. Budding has not given good results but this may be due to wrong technique." Attention is also called to the possibility of crossing the papaw with the tropical *Annonas*.

This possibility was also considered some years ago by the writer, who, in 1909, when in charge of the Subtropical Garden, Miami, Florida, obtained flowers and budwood of the papaw for purposes of experimentation. The pollen never arrived in good condition so that there was no opportunity to attempt a cross with the *Annonas*, but, as previously noted in this REVIEW,[2] several buds of the papaw were inserted on *Annona glabra* which readily united and made a slow growth, although they died during the following year.

Judging from the experience with *Annonas* and *Uvarias* it is believed that budding of the papaw is a simple matter, provided that the buds are cut large from nonpetioled scions of the previous season's growth.

## NOTES ON PLANT INTRODUCTION.

Common as the avocado, *Persea americana* Mill., is in the American Tropics and subtropics it is still a comparatively rare plant in the Tropics of the Old World. Since the American occupation of the Archipelago, this fruit has been repeatedly

[1] Journal of Heredity, Vol. VII, No. 7, 1916, p. 291.

[2] Vol. V, 1912, page. 30.

introduced to the Philippines on both a lárge and small scale, and a mention of the methods employed may be of value to those who are interested in introducing the avocado into other parts of the world.

The earliest introductions, and in fact those as late as in 1915, were made from Hawaii, the fruits being shipped in cold storage to Manila. The seeds were in good condition on their arrival and gave a very satisfactory germination. The only objection to the method is the cost, which is somewhat excessive. In 1916 a shipment of avocado seeds packed in charcoal and shipped in cold storage was received, also from Hawaii. The material did not look promising when the boxes were opened, but by thawing out the seed very slowly the seed came through in remarkably good condition with a germination of 77 per cent.

Avocado seeds have also been received by mail from Florida. In one lot the seeds were wrapped separately in newspapers with a protective covering of corrugated straw board and Manila paper. While some of the seeds were lost, on the whole the shipment arrived in fairly good condition. Another lot was packed in a large amount of sphagnum moss and excelsior. Here a larger percentage of seeds were dead and the rest badly shriveled, evidently by the absorption of the moisture from the seeds by the moss.

From the above experience it would appear that by packing the seed firmly in a tin, or in a paper box lined with waxed paper with just enough dry sphagnum or coconut fiber to fill the cavities between the seeds, there should be no difficulty in successfully mailing the avocado seeds to any part of the world. Avocado scions have likewise been sent successfully from Florida to the Philippines by wrapping each scion separately in damp, not wet, paper and packing them in tins, or in moist sphagnum and oiled paper.

### ADDENDA [1] TO "MYRTACEOUS POSSIBILITIES FOR THE PLANT BREEDER."

In the above-mentioned paper 64 species of plants with edible fruits were enumerated of which 20 belong to the genus *Psidium* and 19 to *Eugenia*. Since the publication of that paper data have been obtained relative to several other species that still further enrich our plant-breeding material among the Myrtaceous plants. There are in fact several Philippine species of *Eugenia* which are known to have edible fruits, but which are

[1] See this REVIEW, Vol. VIII, (1915) No. 3, p. 207.

not being included because of the lack of data regarding them. The additional species are as follows:

*Psidium laurifolium* Berg. LAURIVA. A shrub or a small tree indigenous to Central America. The fruit is 4.5 centimeters in diameter, acid, somewhat resinous, edible.

*Stenocalyx ligustrinus* Berg. IBIRUBA. A shrub, about 2 meters tall, native of Brazil, sometimes cultivated. The fruit is small, 2 centimeters across, globose, black, smooth and edible.

*Eugenia aherniana* C. B. R. TULANA. A shrub or a small, slender tree about 4 meters in height; of wide distribution. The fruits grow among or just below the leaves, and are subglobose, 2.5 centimeters in diameter, dark purple, smooth, rather dry and mealy, edible. Native of the Philippines.

*Eugenia polycephaloides* C. B. R. MAIGANG. A tree of medium size, 15 to 20 meters high, with young growth four angled and at times slightly winged; nearly related to the lipote, and distributed from northern Luzon to the Visayas, at low and medium elevations. The fruit grows in clusters on the bare branches just below the twigs, and is a little more than 1 centimeter across, dark red, acid and edible.

*Eugenia* sp. BALAUSAN. A tree up to 10 or more meters in height, with foliage quite similar to the manquil, but acid when tender. The fruit is borne among or just below the leaves in small clusters up to 5, and is said to be about 2.5 centimeters in diameter, red, fleshy, subacid and of good flavor. Occurs semicultivated in Kalinga, Mountain Province.

*Eugenia* sp. BALUBAT. A shrubby tree indigenous to the Philippines, with small, pale-red fruits and juicy, aromatic flesh that would probably make good preserves.

## ADDITIONAL DATA WITH REFERENCE TO VEGETATIVE PROPAGATION OF TROPICAL FRUITS ETC.[1]

The following directions for shield budding the annatto, caymito, cinnamon, katuri, and pili are given as the results obtained in the course of experimental work conducted at the Lamao experiment station.

ANNATTO, *Bixa orellana*. Use well-matured, greenish-brown petioled budwood; cut the bud 4 to 4.5 centimeters long; age of stock at the point of insertion unimportant.

CAYMITO, *Chrysophyllum cainito*. Use well-matured, non-petioled budwood; cut the buds 3.5 to 4 centimeters long; insert

[1] See also this REVIEW, Vol. IX (1916), page 257, and Bulletin No. 32, page 28, published by the Bureau of Agriculture.

the buds in stock of approximately the same appearance as the scion.

CINNAMON, *Cinnamonum zeylanicum.* Use well-matured but smooth and green, petioled budwood; cut the buds 3.5 to 4 centimeters long; age of stock at the point of insertion of bud unimportant.

KATURI, *Garcinia venulosa.* Use mature, smooth, green, nonpetioled budwood; cut the buds 3.5 to 4 centimeters long; insert the buds in the stock at a point of the same appearance as the scion or at most where streaked with gray.

PILI, *Canarium ovatum.* Use slender, mature, greenish-brown, fairly smooth budwood; cut the buds 4 to 5.5 centimeters long; insert the buds in the stock at a point of approximately the same age and appearance as the scion.

The formation of adventive buds and growth on the severed roots of the camia, *Averrhoa bilimbi* L., and the mombin, *Spondias lutea* L., has recently been observed at the Lamao experiment station.

### NOTES BY CLEVE W. HINES, Sugar Technologist.

### BURNING OF LEAVES AND TRASH BEFORE HARVESTING THE CANE.

It has been the practice in various sugar-producing countries to divide the cane fields into areas of desired size in order to prevent the fire from covering the entire fields and burn off enough cane for the milling during a limited time. In recent years, when there happened to be a temporary shortage of labor, this method of economising labor has been practised on several of the large plantations of these Islands. Experiments here on the burned and unburned cane have shown that this procedure entails the sacrifice of a certain amount of sucrose, especially when it happens that the cane must be left for a time before milling. It was observed that the loss of sucrose was governed largely by the condition of the cane, its stage of maturity, and the weather conditions during the interval between the burning and milling of the cane. A second objection to the burning is that a dark-colored juice is obtained and extra labor is required in the clarification stations. Where plantation-white sugar is being manufactured this item becomes of some considerable importance.

### PALM SUGAR.

A recent article on palm sugar by Dr. Princen Geerligs appeared in the columns of the Louisiana Planter, which mentions the fact that upward of half a million tons of palm

sugar is produced annually in India and that the total area devoted to these trees was no less than 170,000 acres (72,875 hectares). While several species of the sucrose-producing palms thrive there, the *Arenga saccharifera* appears to grow in abundance and furnishes the source of a considerable portion of the sugar.

It is interesting to note in this connection that this tree, which is commonly known as the sugar palm, is found growing wild in practically all parts of the Philippines and that quite a considerable amount of sugar is made from the juice thereof. Extensive experiments were conducted by the writer on the juice of this palm three years ago during which it was learned that a high grade of sugar could readily be made since the impurities present in the juice yielded readily to the ordinary clarifying reagents. (AGRICULTURAL REVIEW, Vol. VII, May, 1914).

### CANE MILLING.

The present grinding campaign opened on November 1 on several of the large sugar plantations. This was practically one month earlier than the usual time of starting and was made possible by the favorable weather conditions during the past two months which induced the storing up of sucrose. In some cases the percentage of sucrose in the cane ranged as high as 14 per cent while the purities during December ranged from 85 to 90. Most of the mills have been running at maximum capacity and will rush the crop through as rapidly as possible in order to obviate the milling of overmature cane which presents many difficulties at the clarification stations. The normal closing season for this country is from the first to the fifteenth of May, but during the past year it was necessary for a number of the factories to continue in operation as late as August 1.

### ROLE OF CALCIUM CARBONATE OR COMMON LIMESTONE ON CANE SOILS.

The West Indian Agricultural News points out that calcium carbonate acts beneficially in the following manner when applied to soils: It neutralizes acidity, hastens bacterial activity, acts to some extent as a plant food, liberates potash from insoluble silicates, and improves the physical condition of the soil.

It has been observed here that when lime is applied to cane lands where the root systems were attacked by fungous diseases an additional improvement was noted in that the attack of the fungous disease was practically eliminated. It was observed,

however, that for immediate results it was preferable to apply the lime in the oxide state, but that care should be taken not to distribute too much of it near the plants during the application. The best results were obtained by bringing the lime and soil well mixed together nearer the plant during each subsequent cultivation, rather than by applying the lime directly to the soil near the plants.

### SHIPMENT OF REFINED SUGAR TO THE UNITED STATES.

During the month of December an unusual shipment of sugar was made to the United States in the form of a consignment of high-grade refined sugar.

This was manufactured at the Luzon Sugar Refinery at Malabon, P. I., and was contracted for during the period when abnormally high prices for that grade of sugar prevailed.

### UBA CANE.

A recent report on the sugar industry in the Island of Mauritius states that uba cane is cultivated to some extent in every sugar district of that island except Black River.

From another source it is learned that uba cane is grown almost exclusively as a source of sugar in certain portions of Natal.

This cane was introduced into the Philippine Islands in 1911 and after numerous trials on the different kinds of land it was abandoned as a source of sugar on account of its low sucrose content. It was observed, however, that the cane was an excellent source of forage for work animals and especially for carabao and cattle. It is the custom to harvest the cane every three or four months while yet immature and in this condition the animals consume the entire stalk. This cane is held in such favor as a green-forage crop that a small area is now grown on all of the important sugar plantations.

### MUSCOVADO FACTORIES.

The molasses type of muscovado sugar was made almost exclusively for export from the Philippine Islands except for the small amount of "pilon" or molasses-free sugar which was exported to the Chinese coast previous to the year 1910, when the first centrifugal sugar factory started. Since that time a number of small factories have been built as well as three modern central factories, the last of these having been constructed three years ago. The planters have become convinced

of the importance of manufacturing centrifugal sugar instead of the muscovado type which finds a market only when there is a scarcity of the former, and in order to remedy the situation a number of the planters are installing vacuum pans to handle the sirup which has been boiled almost to the crystallization point in the open kettles. Although this system is not as economical as that of the central factories, the planters will at least be able to make a sugar which will find a ready market.

## ERRATUM.

Under "Additional Notes on Citrus Canker," page 264, No. 3, Vol. IX, of this REVIEW, the fourth and following lines of the second paragraph should read as below:

* * * of the following localities: Lepanto subprovince, Cervantes; Bontoc subprovince, Lunas, Tiing, and Natonin; Kalinga subprovince, Dauangan, Lubuagan and Naneng; Ifugao subprovince, Bunhian, Kaltiang, and Damag.

(*a*) *Citrus webberii* var. *montana* on orange stock. Lamao experiment station.

(*b*) *Citrus excelsa* on orange stock. Lamao experiment station.

THE PHILIPPINE

# *Agricultural Review*

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## THE SUGAR INDUSTRY OF THE PHILIPPINES.

There is no industry in the Philippines that presents greater opportunities for the Filipino farmer as well as for the American capitalist than does the sugar industry. This condition of affairs is due not only to the fact that these Islands contain vast areas of fertile lands, and climatic and seasonal conditions unexcelled for this particular crop as well as an abundance of labor to handle the crop even when every suitable hectare of land is under cultivation, but it is also due to the fact that this product has become one of the most generally used, most wholesome, and cheapest foodstuffs on the market.

While the cost of sugar to the consumer has increased somewhat during this abnormal state of prices of the world's commodities yet this rise has not been so noticeable in the case of sugar as it has with other foodstuffs, and when it comes to considering the various foodstuffs not as so much bulk but in a more scientific manner, for instance, in the calories of heat a given amount of money will purchase, it will be found that sugar is far cheaper than many of the other necessities of life. The awakening of the world's population in recent years to these facts has been largely responsible for the increased consumption of this product. At the beginning of the war the world's consumption of sugar amounted to something more than eighteen million tons, practically one-half of which was cane sugar. This is a great contrast with the consumption of fifty years ago which was less than a million and a half tons.

The building of sugar centrals in the Islands dates back over a very brief period. In the year 1910 the first large modern factory, the Mindoro Sugar Factory, was constructed. This was followed two years later by the San Carlos factory of Occidental Negros and two years later the great Calamba factory was built. All of these factories have been put up with considerable foresight since they were so designed that they might be increased in capacity by the addition of extra machinery to care for the increased crop production that would be bound to follow with the introduction of modern methods. The last-

named factory had an initial capacity of 1,200 tons of cane or 150 tons of sugar per day and has already been increased by fifty per cent in capacity over the original design. So encouraging has the harvest of the past year proved that plans are now under way to double the present output as soon as extra machinery can be secured.

The modern sugar central is an institution that means more to the Filipino people than any one thing that has come to both the capitalist and workingman alike. It furnishes the working class steady employment and better wages than was possible under the old system. They are thus able to live better and happier, and above all to bring up their families under better conditions than was possible under the old half-time employment and low scale of wages.

At present there is a lull in the building of central factories here. This is due to the fact that it is next to impossible to secure machinery and equipment on a large scale under the present abnormal conditions, especially in view of the difficulty that would be experienced in transporting this material here due to the lack of shipping facilities. However, the various favorable locations are being investigated and plans formulated for the building of numerous central factories as soon as equipment is available.

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## GREEN-MANURE AND COVER CROPS IN THE PHILIPPINES.

Prior to the American occupation, the use of leguminous cover and green-manure crops in the Philippines was practically unknown. The wide-spread use thereof since that time cannot, however, be accredited wholly to American influence, but is due partly to the more general awakening in regard to the uses of such plants the world over.

Of late years such plants as the Lyon velvet bean, *Stizolobium niveum,* Florida black velvet bean, *Stizolobium deeringianum,* Coffman bean, *Stizolobium pachylobium,* cowpeas, *Vigna unguiculata,* native mungo, *Phaeseolus radiatus,* and patani, *Phaseolus lunatus,* have entered into the general agricultural scheme of the Islands and are now in common use and occupy a permanent place on most well conducted plantations. Besides their use as covering crops in permanent plantations to help handle the weed situation and their use to restore organic matter and nitrogen in depleted soils, such plants as patani, Lyon, Coffman, and Florida velvet beans are used in combination with annual plowing to rid otherwise valuable agricultural land from "cogon" and other obnox-

ious native grasses. By the judicious use of such smothering plants the Bureau of Agriculture has demonstrated that in the course of a few years cogon lands can successfully, and at little cost, be brought under remunerative cropping, at the same time greatly enriching the soil in humus and organic nitrogen.

Perhaps one of the greatest "finds" rewarding the Bureau of Agriculture's efforts along this line, in recent years, has been the introduction and successful acclimation of the Florida black velvet bean, a plant answering all the requirements, under Philippine conditions, of a successful covering or smothering crop.

The bean was introduced about two years ago and has ever since given extraordinary satisfaction as a covering crop and in the course of a few years, due to the increasing demands for such crops, the plants will become well disseminated throughout the Islands. The features which make the plant particularly valuable and superior to other such crops are its remarkable vegetative growth in a short period and its longevity. The plants under Philippine conditions produce a remarkable growth, completely covering the ground and climbing over and choking out the other plants in the near vicinity in two to three months after planting. The plant flowers and fruits in from eight to ten months, and its smothering effect is good for a year before it begins to die out. Consequently it is particularly valuable for reclaiming cogon lands.

# ADDITIONAL OBSERVATIONS ON THE CITRUS FRUITS IN THE PHILIPPINES.[1]

By P. J. WESTER, *Horticulturist in Charge of Lamao Experiment Station.*

## PRELIMINARY REMARKS.

Two years ago an exposition of the Philippine citrus fruits, including descriptions of 25 species and subspecies, several of which were apparently new in botanical literature, was published in this REVIEW, but owing to lack of material a few of the descriptions were incomplete. Since then plants of some of these species have flowered at Lamao or material has been obtained from outside sources, which makes the missing data available for publication. Since the publication of the above paper the citrus canker, *Pseudomonas citri* Hasse, has been found prevalent in the Philippines [2] and attempts have also been made to find a remedy for this disease. Whatever may be the value of therapeutic agents against the citrus canker it is apparent that the culture of immune or very resistant citrus varieties is the most practical solution of the citrus-canker problem in this Archipelago. In this connection the large citrus collection of native as well as exotic citrus forms assembled at the Lamao experiment station has provided a unique opportunity for observation of the susceptibility of the various species and cultivated varieties of the genus *Citrus* to the citrus canker, and the table hereinafter which includes the major part of the citrus collection at Lamao has been prepared from a series of notes taken by the writer in January, 1917.

It should be stated that according to observations of the canker by the writer, which extend back to 1912 (the disease was noted but not identified at the time), the virulence of the disease

[1] For previous discussions on this subject see this REVIEW, Vol. VI, 1913, p. 125; Vol. VIII, 1915, p. 5; Vol. IX, 1916, p. 133, p. 155, p. 264, p. 278, and Vol. X, p. 51, and B. of A. Bulletin No. 27, "Citriculture in the Philippines," 1913.

[2] In addition to other localities previously mentioned in this publication the writer recently noted canker on various species of *Citrus* in Zamboanga, Tetuan, the Patalon Plantation, east of San Ramon Farm, Mindanao and in the Island of Basilan.

is periodic, at one time of the year seriously affecting the plants, while at other times, without any control measures having been taken, it gradually diminishes until, from a practical point of view, it appears to be a negligible factor in most species. Therefore, the degree of susceptibility of a species or a variety to canker as indicated in the table in this paper should not be regarded as absolute, but rather as comparative. It should perhaps also be stated that the canker occurred in a rather mild form at the time when the notes were taken and many varieties that are here reported as slightly attacked may at another time be more seriously affected than would appear in the table. As to the degree of susceptibility in general of the various species the statements previously made by the writer [1] hold good, except that *C. limetta* should be included with the species most seriously affected. In this connection the immunity or at most the extremely slight affection of the "Tahiti" lime is of exceedingly great interest from a taxonomic viewpoint considering the differences in a number of botanical characteristics between the ordinary lime and the Tahiti. It will be noted that a very considerable number of forms of various species are reported immune. This refers of course to the condition of the plants at the time of making the observations. The reported immunity of a species or a variety to canker should be considered with suspicion until it has been under constant observation for a considerable length of time. On the other hand it should be stated that those forms that are here reported as "immune" or "nearly immune," are so resistant to the canker that the presence of canker does not or would not affect the production of the trees. As a matter of fact the writer does not recall the observation of a single instance of canker affection on the fruit of the mandarin and the calamondin, and the infection of pomelos as seen in the market cannot be regarded as serious.

The citrus collection at Lamao contains one set of budded trees on known stocks, including two trees of each number, except in a few instances where one tree has died, one set of seedling trees, mostly of Philippine origin, and imported trees the stock of which is not known. Except in a few cases each number in this last set is represented by two, usually four, or even more, plants, each of which is designated by an individual number separated from the serial number by a dash. For instance, No. 741, *Citrus decumana,* includes observations on 6 seedlings from one lot of seed represented by the numbers 3, 4, 6, 7, 13

[1] See this REVIEW, Vol. IX, 1916, p. 156.

and 17 (see table). In many cases when the seedlings of a number show no distinct individualities, the individual seedling numbers do not appear in the table. All names in quotation marks indicate budded varieties.

While aware of the nomenclatorial changes that have recently been made relative to the citrus fruits, for the convenience of the reader it has been thought best to adhere to the names used in previous papers on citrus fruits in this periodical.

## DESCRIPTIONS AND COMMENTS.

*Citrus nobilis* var. *papillaris* Blanco. TIZON. (Pl. V., *a*).

From flowering material received in January from Mr. Q. Aguilera, Lipa, Batangas, the flowers of this species are found to occur in axillary cymes up to 6; the calyx is small, scarcely cupulate; corolla 30 to 40 millimeters across; petals 4 to 5, white, fleshy; stamens 19 to 25, equal, inferior to stigma, filaments united into groups of several; ovary elevated on a disk, short obovoid, 2 millimeters long; style 8 millimeters long, distinct, slender; stigma club-shaped.

Continued observation of the tizon tends to confirm the opinion that it is one of the best "native" Philippine citrus fruits. At no time has the canker affection been anything but exceedingly light on the tizon, and from this point of view together with its other good qualities it may be considered as being of exceptional value for breeding purposes.

*Citrus mitis* Blanco. CALAMONDIN. (Pl. VI, *d.*)

This species has been tried as a stock for the various cultivated citrus fruits. At this time it is of course too early to pass on its final value in this respect, but so far it appears promising for at least the orange, mandarin and some types of the pomelo, although other varieties of the pomelo make a very indifferent growth on the calamondin.

According to Dr. H. C. Brill, organic chemist, Bureau of Science, Manila, the pulp of the calamondin analyzes as follows:

| | Per cent. |
|---|---|
| Solids | 11.55 |
| Sucrose | 0.68 |
| Reducing sugars | 1.67 |
| Protein | 0.83 |
| Citric acid | 4.94 |
| Ash | 0.56 |

The pulp constitutes 80 per cent of the total weight of the fruit.

The calamondin is very resistant to the canker, and trees may possibly be found that are immune to the disease. Therefore,

this species should also be of considerable value for hybridization in breeding canker-resistant citrus fruits.

*Citrus decumana* Murr. POMELO var. PANUBAN.

The flowers of this form, as collected by Mr. D. B. Mackie in the Mountain Province, grow 2 to 5 in axillary cymes, rarely solitary; calyx large, cupulate; corolla 45 to 50 millimeters in diameter; petals 4 to 5, fleshy; stamens 22 to 30, about equal; filaments united in groups of several; ovary large, 5 millimeters long, oblate; style 10 to 11 millimeters long, distinct. The fruit is considerably larger than is indicated in the original description of the panuban.

While the panuban is a very distinct form of the pomelo, it is scarcely sufficiently so to deserve rank as a subspecies. Where this variety occurs the fruit is highly esteemed and is transported over considerable distances, considering the condition of the roads and means of transportation.

*Citrus longispina* Wester. TAMISAN. (Pl. II, *b*.)

This interesting species produced a few flowers at the Lamao experiment station in May, 1915.

The flowers are terminal, solitary, 25 millimeters in diameter, fragrant; calyx small, not cupped; petals 5, white, rather thin, sometimes reflexed; stamens 28 to 30, unequal; filaments usually free; ovary elevated on a pale-green disk, obovoid; style distinct, comparatively long; stigma knob-like.

At this station the plants of this distinct species are making a rapid and vigorous growth. In the young stage the plants were very severely attacked by canker but now appear to have outgrown the disease.

The Visayan name "Tamisan" has been adopted as a more convenient common name for this species in place of Talamisan.

*Citrus webberii* Wester. CALPI. (Pl. VI, *a*, *b*.)

Since the description of this variable species was first published, flowering material has been obtained in more abundance, both from Bontoc and at Lamao, and the flowers are found to occur solitary or up to 4 in a cluster, terminal or axillary, the stamens varying from 19 to 24, with united or free filaments.

The calpi appears to be widely distributed in the Archipelago from Bontoc in northern Luzon to Mindanao. In Nueva Vizcaya it makes a very attractive tree and attains a height of 10 meters.

As a stock for the other cultivated citrus fruits the calpi appears more congenial and produces a more rapid growth than any other of the citrus species of Philippine origin including the cabuyao and calamondin. (Pls. III, *d*, IV.)

The Bicol name "Calpi" has been adopted as the common name instead of "Alsem" as being more convenient and attractive.

*Citrus webberii* var. *montana* Wester. GUYOD. (Plates I, *a*, VI, *c*.)

This form is distinguishable from *C. webberii* chiefly by its more drooping branches, and larger, corrugate fruits; the eating qualities are about equal to those of the calpi. The stamens are usually free.

The guyod is the most ornamental species in the genus *Citrus* which has been noted by the writer.

*Citrus histrix* DC. CABUYAO. (Pl. VII, *a*.)

The plants that seem to belong to this species are extremely variable both in foliage characters, particularly in the fragrance of the leaves, and in the fruit, and as the plants in the citrus collection at Lamao become of flowering and fruiting age several subspecies and perhaps species may be distinguished among them. Certain distinct forms appear to be nearly immune to canker. One tree apparently belonging to this species was found in Tayabas, the leaves of which emitted a strong peppermint odor, but the plants obtained unfortunately died. In nothern Kalinga, Luzon, a cabuyao tree was found by the writer which had perfectly round fruits about the size of oranges, but the scions perished before reaching Lamao. In symmetry and attractive form, certain types of the cabuyao probably surpass all other citrus fruits.

The orange, pomelo, lemon and mandarin have been budded on the cabuyao (Pls. II, *c*; III, *a, b, c*.) and the growth is fairly satisfactory, though the species is perhaps not quite as congenial a stock as the calpi and the calamondin.

*Citrus excelsa* var. *davaoensis* Wester. (Pl. V, *d*.)

P. I. No. 1,009 flowered sparingly in January, 1912, at Lamao.

The flowers are sweet scented, and grow in compact axillary cymes of 4; calyx rather small, scarcely cupped; corolla 35 millimeters across; petals 4 to 6, fleshy, tinged with purple on the outside; stamens 28 to 33, inferior to stigma; filaments free or more or less united into groups of several; ovary oblate, about 2 millimeters long; style distinct, stout, 5 millimeters long.

Because of the great vigor of this subspecies and of *C. excelsa*, hope was at first entertained that these two plants might be useful as stock, but neither seem to have much value in this respect. Large numbers have been budded to the cultivated citrus fruits but with very unsatisfactory results. As stocks these two forms have an unusual propensity for sending forth wild sprouts below

the buds; being excessively spiny the plants are unpleasant to handle, and the buds do not grow well and are frequently subject to gumming. The tamisan and some forms of the cabuyao so far have made a good growth on *C. e. davaoensis.*

*Citrus japonica* Thunb. KUMQUAT, "OMIKINKAN."

An evergreen shrub of upright growth, up to 4 meters high, usually spineless; leaves rarely exceeding 9 millimeters in length and 32 millimeters in width, broadly lanceolate, undulate, finely crenate on the apical half of the leaf; base rounded; apex blunt; petioles about 10 millimeters long, only partially margined; flowers axillary, usually solitary, sometimes in pairs, 17 millimeters across, sweet scented; calyx small; petals 4 to 5, white, fleshy; stamens 18 to 20, connate, unequal; ovary small, roundish to obovoid, 5 to 6 loculed; style short and distinct. Fruit round to roundish oblong, rarely exceeding 30 millimeters in length; rind smooth, greenish yellow to golden, aromatic, sweetish, edible; flesh juicy and acid.

The "OMIKINKAN" kumquat was introduced by the Bureau of Agriculture from India, in 1912, but the plant led a precarious existence until in 1915, when it started to make a good growth; it bloomed and fruited for the first time in 1916. The kumquat would probably succeed better at a greater elevation than obtains at Lamao (15 meters above sea level).

*Citrus limetta* Risso. Var. HONGKONG. (Pl. V, *b*.)

A shrub 4 to 5 meters high, smooth or bearing weak spines; leaves variable, rarely exceeding 140 millimeters in length and 65 millimeters in width, elliptical-oblong to obovate-oblong, crenate, usually notched; base rounded; petiole 10 to 15 millimeters long, margined, tinged with purple when tender; flowers axillary, solitary, or not more than 5 in terminal clusters; buds purplish; calyx not large, cupulate; corolla about 33 millimeters across; petals 4 to 5, tinged with purple outside; stamens unequal, 21 to 25; filaments united into groups of several, sometimes free; ovary 3 millimeters long, oblong, apex tapering; style 7 millimeters long; stigma knob-like, large. Fruit 45 millimeters in diameter, round, tending to oblate; apex flattened; surface green with a tinge of orange, smooth; oilcells usually sunken; rind very thin, not loose like mandarin but peeling readily from the flesh; locules 9, adhering to each other as in the orange; flesh of about the color of that of the orange or a trifle more greenish, juicy, and strongly acid; seeds rather similar to those of the lime.

The above description has been made from an unnamed plant received in April, 1913, from Mr. F. P. de V. Soares, Hongkong, which is growing under No. 2985 at Lamao, where it fruited in

1917. It has been referred provisionally to the lime. When examined in detail the plant presents many differences from the ordinary lime, and in fact it does not correspond to any species in the genus known by the writer. It would appear to have borrowed some characters from both the lime or lemon and the mandarin, and is in all probability a spontaneous hybrid. For all practical purposes it may be used like the lime and the lemon and makes a good ade with distinct flavor and aroma. It may be considered a valuable addition to the cultivated citrus fruits.

*Table showing the degree of citrus canker affection in the citrus collection at the Lamao Experiment Station.*

| P. I. No.— | Botanical name. | Canker affection. | | | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | Serious. | Medium. | Slight. | Nearly immune. | Immune. | |
| 740 | *Citrus aurantium* | v | v | | | | |
| 923 | do | | v | | | | |
| 966 | do | | | v | | | |
| 1728 | do | | v | v | | | |
| 1736 | do | | v | | | | |
| 2340 | do | | | | | v | From the Mountain Province. |
| 2344 | do | | | v | | | |
| 2365 | do | | | | v | | |
| 2568 | do | v | v | | | | |
| 2569 | do | | v | v | | | |
| 2648 | do | | | v | | | |
| 2649 | do | | | v | | | |
| 3660 | do | | v | | | | |
| 3843 | do | | | | | v | Origin, Saigon, Indo-China. |
| 5699-1 | do | | | v | | | |
| 706 | *Citrus aurantium*, "Bahia" | | v | v | | | |
| 1720 | do | | | | v | | |
| 2698 | *Citrus aurantium*, "Boone" | | v | v | | | |
| 4117 | *Citrus aurantium*, "Brown" | | v | v | | | |
| 2695 | do | v | | v | | | |
| 4124 | *Citrus aurantium*, "Carleton" | | v | | | | |
| 4119 | *Citrus aurantium*, "Dugat" | | | v | | | |
| 4120 | *Citrus aurantium*, "Duroi" | | | v | | | |
| 3886 | do | | | | v | | |
| 2689 | *Citrus aurantium*, "Enterprise." | | | v | | | |
| 1260 | *Citrus aurantium*, "Excelsior." | | | | v | | |
| 4126 | *Citrus aurantium*, "Foster" | | | v | | | |
| 1701 | *Citrus aurantium*, "Holdfast" | | | | v | | |
| 2691 | *Citrus aurantinm*, "Homossassa." | | | v | | | |
| 1258 | *Citrus aurantium*, "Jaffa" | | | v | | | |
| 1719 | do | | | v | v | | |
| 1637 | do | | | v | v | | |
| 1258 | do | | | v | v | | |
| 1722 | *Citrus aurantium*, "Joppa" | | | | v | | |
| 1714 | *Citrus aurantium*, "Larantta." | | | v | | | |
| 4123 | *Citrus aurantium*, "Magnum Bonum." | | v | | | | |
| 1259 | *Citrus aurantium*, "Malta Blood." | | | v | | | |
| 2697 | do | | v | v | | | |
| 2694 | *Citrus aurantium*, "Majorca" | | | v | v | | |
| 1743 | *Citrus aurantium*, "Mediterranean." | | v | v | | | |
| 1705 | do | | | | v | | |
| 1277 | *Citrus aurantium*, "Seville" | | | | v | | |
| 1270 | *Citrus aurantium*, "St. Michael." | | | v | | | |

*Table showing the degree of citrus canker affection in the citrus collection at the Lamao Experiment Station*—Continued.

| P. I. No.— | Botanical name. | Canker affection. Serious. | Medium. | Slight. | Nearly immune. | Immune. | Remarks. |
|---|---|---|---|---|---|---|---|
| 1742 | *Citrus aurantium*, "Navelencia." | | | v | | | |
| 1635 | *Citrus aurantium*, "Pineapple." | | | v | | | |
| 2686 | do | | v | v | | | |
| 1917 | *Citrus aurantium*, "Ruby" | | | v | | | |
| 1639 | do | | | | v | | |
| 1273 | *Citrus aurantium*, "Satsumamikan." | | | | v | | |
| 2696 | *Citrus aurantium*, "Tardiff" | | | v | | | |
| 1706 | *Citrus aurantium*, "Valencia" | | | | v | | |
| 51 | do | | | | v | | |
| 1266 | *Citrus aurantium*, "Whitaker." | | | v | | | |
| 1715 | *Citrus aurantium*, "White Siletta." | | | v | | | |
| 1744 | *Citrus aurantium*, "Washington Navel." | | v | v | | | |
| 2114 | do | | v | v | | | |
| 1711 | do | | | v | | | |
| 1636 | do | | | v | v | | |
| 549-1 | *Citrus decumana* | | | | | v | Very distinct type. |
| 560-1 | do | v | v | | | | |
| 741-3-4-6-7-13-17 | do | | v | v | | | |
| 742-1-2 | do | | | v | | | |
| 773-1-2-4 | do | | | v | | | |
| 750 | do | | | v | | | |
| 891 | do | | | v | | | Seedless variety from Cabanatuan, Nueva Ecija. |
| 893 | do | | | v | | | Seedless pomelo from Cabanatuan, Nueva Ecija. |
| 897-2-3 | do | | | v | | | |
| 899 | do | | | | v | | |
| 969-2 | do | | | v | | | |
| 990-1-2-3 | do | | | v | | | |
| 1448-1 | do | v | | | | | |
| 1646-2-4 | do | | | v | | | |
| 2257-5-6 | do | | v | | | | |
| 2257-1-2-3-4 | do | | v | v | | | Very distinct type. |
| 2265 | do | | | v | | | |
| 2402 | do | | | v | | | |
| 2461-1-3-4-6-7 | do | | v | v | | | |
| 2403 | do | | | v | | | |
| 2503-2-3-4 | do | v | | | | | |
| 2503 | do | | | | v | | |
| 3657 | do | | | | v | | |
| 3661 | do | | | | v | | Quality fair to good. |
| 3662 | do | | | | v | | Quality fair to good. |
| 3673 | do | | v | | | | |
| 3384 | do | v | | | | | |
| 5699-6 | do | | v | v | | | |
| 1995 | *Citrus decumana*, "Bangkok" | | | v | | | Seedless pomelo from Bangkok, Siam. |
| 1633 | *Citrus decumana*, "Case" | | | | v | | Said to be a pink-fleshed pomelo of good quality. |
| 2687 | *Citrus decumana*, "Duncan" | v | | | | | |
| 1333 | *Citrus decumana*, "Ellen" | | v | | | | |
| 4868 | *Citrus decumana*, "Kellogg" | | | | v | | A variety from Nueva Ecija. Reported to be of exceptional quality. |
| 2690 | *Citrus decumana*, "March" | v | | | | | |
| 1631 | do | | v | v | | | |
| 1707 | do | | v | | | | |
| 3882 | *Citrus decumana*, "McCarty" | v | | | | | |
| 2700 | do | v | | | | | |
| 4121 | do | v | | | | | |
| 3876 | *Citrus decumana*, "Nakoin" | v | | | | | Of Siamese origin. |
| 1334 | *Citrus decumana*, "Pernambuco." | v | v | | | | |

*Table showing the degree of citrus canker affection in the citrus collection at the Lamao Experiment Station*—Continued.

| P. I. No.— | Botanical name. | Canker affection. | | | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | Serious. | Medium. | Slight. | Nearly immune. | Immune. | |
| 4125 | *Citrus decumana*, "Royal" | | v | | | | |
| 3389 | *Citrus decumana*, "Siam" | | | | v | | A Siamese seedless pomelo. |
| 3442 | *Citrus decumana*, "Sinsemi" | | v | | | | Do. |
| 3391 | *Citrus decumana*, "Boyle" | | v | v | | | Do. |
| 3392 | *Citrus decumana*, "Yugelar" | | | | | v | Do. |
| 1632 | *Citrus decumana*, "Triumph" | | | v | | | |
| 1713 | do | | v | v | | | |
| 4118 | *Citrus decumana*, "Walters" | v | | | | | |
| 5144 | *Citrus decumana*, "Lias" | v | | | | | Panuban var. from Lias, Mountain Province. |
| 5146 | *Citrus decumana*, "Gaerlan" | v | v | | | | Panuban var. from Bontoc, Mountain Province. |
| 1618 | *Citrus decumana*, "Sampson" | | | v | v | | Tangelo; hybrid between pomelo and mandarin. |
| 1948 | do | | | v | | | Do. |
| 3385 | do | | | v | | | Do. |
| 741-5 | *Citrus excelsa* (Pls. I, *b*; V, *c*.) | | | v | | | |
| 741-8-12-21 | do | | | | v | | |
| 741-16-18-19-20 | do | | | | | v | |
| 833 | do | | | v | | | |
| 833-1-2-3-4 | do | | | v | | | |
| 835 | do | | v | v | | | The best variety of this species at Lamao that so far has fruited. |
| 853-1-2-3-5-6 | do | | | v | | | |
| 889-2 | do | | | v | | | |
| 1013-1-2-4 | do | | | v | | | |
| 1727 | do | | v | | | | |
| 2655 | do | | | v | | | |
| 3388 | *Citrus* sp. near *excelsa* | | v | v | | | Of Saigon origin. |
| 3841 | do | | v | | | | Do. |
| 3888 | do | | | v | | | Do. |
| 3844 | do | | | v | | | Do. |
| 970 | *Citrus excelsa* var. *davaoensis* (Pl. V, *d*.). | v | v | | | | |
| 970-5-6 | do | v | | | | | |
| 1009-2-3-4 | do | | v | | | | |
| 1257 | *Citrus japonica*, "Omikinkan" | | | | | v | |
| 741-11 | *Citrus limetta* | | | v | | | |
| 741-15 | do | | v | | | | |
| 818-1 | do | v | | | | | |
| 901-1-2-3-4 | do | v | v | | | | |
| 902 | do | | v | | | | A Philippine lime of superior quality. |
| 958 | do | v | | | | | Of Philippine origin; of excellent quality. |
| 1400-1-2-3-4 | do | v | | | | | |
| 2190-1-2-3-4 | do | v | v | | | | |
| 2346-15 | *Citrus* sp. near *limetta* | v | | | | | Origin Hongkong. |
| 1708 | *Citrus limetta*, "Tahiti" | | | | | v | |
| 4122 | do | | | | | v | |
| 3669 | *Citrus limetta*, "Everglade" | v | | | | | |
| 3670 | *Citrus limetta*, "Trinidad" | | v | | | | |
| 2346 | *Citrus limetta*, var | | | | v | | Very distinct and interesting type. |
| 2346-5-7-8 | do | v | v | | | | |
| 3672-1-2-3-4 | do | v | v | | | | |
| 741-1-10-23-24-25 | *Citrus limetta* var. *aromatica* | | v | | | | |
| 897-5-7 | do | | v | | | | |
| 975 | do | v | | | | | |
| 1749 | do | | v | | | | |
| 2182 | do | | v | | | | |
| 2500 | do | v | v | | | | |
| 2532 | do | v | | | | | |
| 4827 | do | | v | | | | |
| 691 | *Citrus limonum*, "Belair" | | | v | v | | |
| 692 | *Citrus limonum*, "Villafranca." | | | | v | | |

*Table showing the degree of citrus canker affection in the citrus collection at the Lamao Experiment Station*—Continued.

| P. I. No.— | Botanical name. | Canker affection. Serious. | Medium. | Slight. | Nearly immune. | Immune. | Remarks. |
|---|---|---|---|---|---|---|---|
| 708 | *Citrus limonum*, "Lisbon" | | | | v | | |
| 1634 | *Citrus limonum*, "Valencia" | | | | v | | |
| 1642 | *Citrus limonum*, "Clarke" | | | | v | | |
| 1702 | *Citrus limonum*, "Villafranca." | | | | | v | |
| 1703 | *Citrus limonum*, "Lisbon Variegated." | | | | v | | |
| 1704 | *Citrus limonum*, "Bengal" | | | | v | | |
| 1710 | *Citrus limonum*, "Sicily" | | | | | v | |
| 1712 | *Citrus limonum*, "Thornless" | | | | | v | |
| 1723 | *Citrus limonum*, "Messina" | | | | v | | |
| 875 | do | | | | v | | |
| 741-22 | *Citrus limonum* var | | | v | | | Very distinct form. |
| 3675 | *Citrus limonum*, "Rough" | | v | v | | | |
| 3959 | *Citrus limonum* var | | | v | | | |
| 3655 | *Citrus* sp. near *limonum* | v | | | | | |
| 790-1-2-3-4-5-6 | *Citrus histrix* (Pl. VII *a*.) | | | | | v | Very distinct type; from Bataan. Fruit of remarkably good quality. |
| 807-1-2-3-4-5-6-7-8-9-10-11 | do | | v | | | | |
| 834-1-2-3-4 | do | | | v | | | |
| 834-5-6-7-8 | do | | | | | v | Very distinct form. |
| 834-9-10 | do | | | | v | | |
| 2570 | do | | | | | v | |
| 3668 | do | | | | | v | Very distinct type, said to be of very good quality for ade. From Sellner's hacienda, Abukay, Bataan. |
| 2494 | do | | | v | | | |
| 4214 | do | v | v | | | | |
| 4225 | do | v | | | | | |
| 4822 | do | v | | | | | |
| 4830 | do | | v | | | | |
| 5102-2-3-4-5 | do | v | | | | | |
| 5102-1 | do | | | v | | | |
| 5699-11 | do | | v | | | | |
| 3656 | *Citrus histrix* var. *boholensis* | | | v | | | |
| 4824 | do | | | v | | | |
| 3673-1-2-3-4-5-6-8-9-7. | *Citrus histrix* var. *torosa* (Pl. VII*b*). | v | v | | | | |
| 2535 | do | v | | | | | |
| 5137 | do | | v | v | | | |
| 5189 | do | | | v | | | |
| 27-3-4-12-15-16-17. | *Citrus medica* | | | | | v | |
| 790-7 | do | | | | | v | |
| 840 | do | | | v | | | |
| 1010-3-4 | do | | v | v | | | |
| 1278 | *Citrus medica*, "Finger" | | | v | | | |
| 1716 | *Citrus medica*, "Common" | | | | v | | |
| 2499-1-2-3-4-5-8-9. | do | | | | v | | |
| 2652-2 | do | | | | | v | |
| 3836 | do | | | | | v | |
| 4739 | do | | | | | v | |
| 4826 | do | | | | | v | |
| 5699-5 | do | | | | v | | |
| 5699-8-9 | do | | | | | v | |
| 2264 | *Citrus* sp. near *medica* | | | v | | | |
| 19-5-7 | *Citrus medica odorata* | | | | | v | |
| 19-6 | do | | | | v | | |
| 624-3 | do | | | | v | | |
| 809-3 | *Citrus medica nanus* | | | | | v | |
| 2384 | do | | | | v | | |
| 5699-4 | do | | | | v | | |
| 2183 | *Citrus* sp. near *medica* | | | v | | | |
| 1010-5-6-7 | do | | | v | | | |
| 848 | do | | | | v | | |
| 2372 | *Citrus macrophylla* | v | v | | | | |

*Table showing the degree of citrus canker affection in the citrus collection at the Lamao Experiment Station*—Continued.

| P. I. No.— | Botonical name. | Canker affection. Serious. | Medium. | Slight. | Nearly immune. | Immune. | Remarks. |
|---|---|---|---|---|---|---|---|
| 4820 | *Citrus macrophylla* | v | v | | | | |
| 741-9 | *Citrus mitis* (Pl. VI*d*) | | | | | v | |
| 741-14 | do | | | | v | | |
| 772 | do | | | | | v | |
| 1718 | do | | | | | v | |
| 2184 | do | | | | v | | |
| 2332 | do | | | | | v | |
| 2355 | do | | | | | v | |
| 2513 | do | | | | | v | Of excellent quality. |
| 2653-5 | do | | | | v | | |
| 2534 | do | | | | | v | Do. |
| 2346-6 | do | | | | | v | |
| 5699-2 | do | | | | | v | |
| 2502 | *Citrus micrantha* (Pl. VII*c*) | | | v | | | |
| 2502-1-2 | do | | | v | | | |
| 1981 | do | | | | | v | |
| 5699-3 | do | | v | v | | | |
| 1982-1-2-3-4-5-6-7-8. | *Citrus* sp. near *micrantha* | v | v | | | | |
| 4832 | *Citrus micrantha microcarpa* (Pl. VII*d*). | | | v | | | |
| 4821 | do | | | v | | | |
| 3659 | do | | v | | | | |
| 2529-1-2-3-4-5 | *Citrus longispina* (Pl. II, *b*.) | | v | v | | | |
| 2528-2-4-5-6-8-9-10. | do | | v | v | | | |
| 4838 | do | v | | | | | |
| 4839 | do | v | | | | | |
| 4840 | do | | v | | | | |
| 3658 | do | | v | | | | |
| 4833 | do | | | v | | | |
| 1647-1-2-3-4 | *Citrus nobilis* | | | | | v | |
| 1913-1-2-3-4 | do | | | | v | | |
| 2346-1-2-3-4 | do | | | | v | | |
| 2448-1-2-3-4 | do | | | | v | | |
| 2448-5-6-7-8-9-10-11-12. | do | | | v | v | | |
| 2469-1-2-3-4 | do | | | | v | | |
| 2527-1-2-3-4 | do | | | | v | | |
| 2527-5-6 | do | | | v | | | |
| 2528-1-3-7 | do | | | | | v | |
| 2650 | do | | | | v | | |
| 2651-1-2-3-4 | do | | | | | v | |
| 2653 | do | | | | | v | |
| 4828 | do | | | | | v | |
| 1256 | *Citrus nobilis*, "Ladu" | | | | | v | |
| 1261 | *Citrus nobilis*, "Mandarin" | | | | | v | |
| 1262 | *Citrus nobilis*, "Suntara" | | | | | v | |
| 1263 | *Citrus nobilis*, "Sikkim" | | | | | v | |
| 1265 | *Citrus nobilis*, "China" | | | | | v | |
| 1267 | *Citrus nobilis*, "Szinkom" | | | | v | v | |
| 1271 | *Citrus nobilis*, "Kishiu" | | | | | v | |
| 1272 | *Citrus nobilis*, "Konda Narun" | | | | | v | |
| 1275 | *Citrus nobilis* "Unshiu" | | | | | v | |
| 1276 | *Citrus nobilis*, "Suntara Nagpur." | | | | | v | |
| 1335 | *Citrus nobilis*, "Oneco" | | | | | v | |
| 1918 | *Citrus nobilis*, "Dancy" | | | | | v | |
| 2693 | *Citrus nobilis*, "King" | | | v | v | | |
| 5139 | *Citrus nobilis*, "Ubay" | | | | | v | |
| 744 | *Citrus nobilis* var. *papillaris* (Pl. V*a*) Molana. | | | | v | | |
| 745 | *Citrus nobilis* var. *papillaris* (Pl. V*a*) Medilla. | | | | v | | |
| 5138 | *Citrus nobilis* var. *papillaris* (Pl. V*a*) Malvar. | | | | | v | |
| 5143 | *Citrus nobilis* var. *papillaris* (Pl. V*a*) Rafael. | | | | v | | |
| 2346-12-13 | *Citrus nobilis* var | v | | | | | Of Honkong origin. |
| 2346-14 | *Citrus* sp. near *nobilis* | v | v | | | | Of Honkong origin, a very peculiar type with calamondin-like leaves and large apron. |

(*a*) Philippine pomelo on orange stock; note habit. Lamao experiment station.

(*b*) *Citrus longispina* Wester. Tamisan.

(*c*) Lime budded on cabuyao.

(a) (b) (c) (d)

A study in bud unions: (*a*) Pomelo on Cabuyao; (*b*) Calpi on Cabuyao; (*c*) Mandarin on Cabuyao; (*d*) Orange on Calpi. Lamao experiment station.

(a) (b) (c) (d)

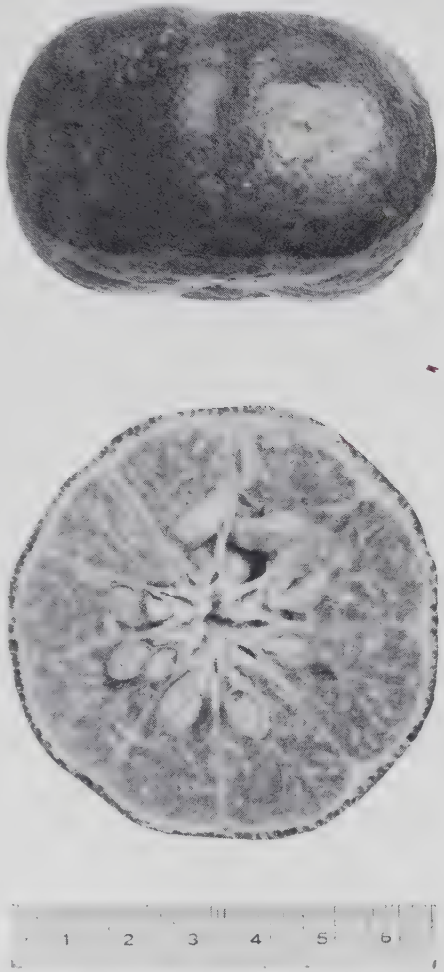
A study in bud unions: (a) Mandarin on Calpi; (b) Tizon on Calpi; (c) Pomelo on Calpi; (d) Lemon on Calpi. Lamao experiment station.

(*a*) *Citrus nobilis* var. *papillaris* Blanco. TIZON.

(*b*) *Citrus limetta* Risso. Var. "HONGKONG."

(*c*) *Citrus excelsa* Wester. LIMON REAL.

(*d*) *Citrus excelsa* var. *davaoensis* Wester.




(*a*) *Citrus webberii* Wester. CALPI.

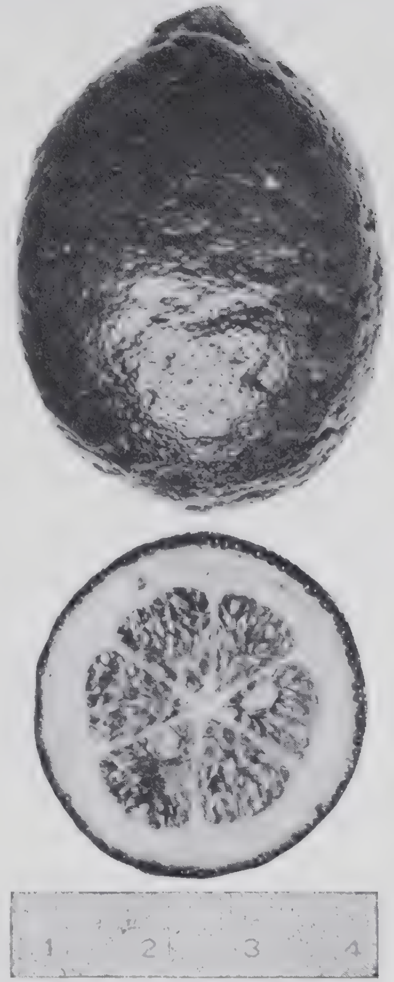
(*b*) *Citrus webberii* Wester. CALPI.


(*c*) *Citrus webberii* var. *montana* Wester.

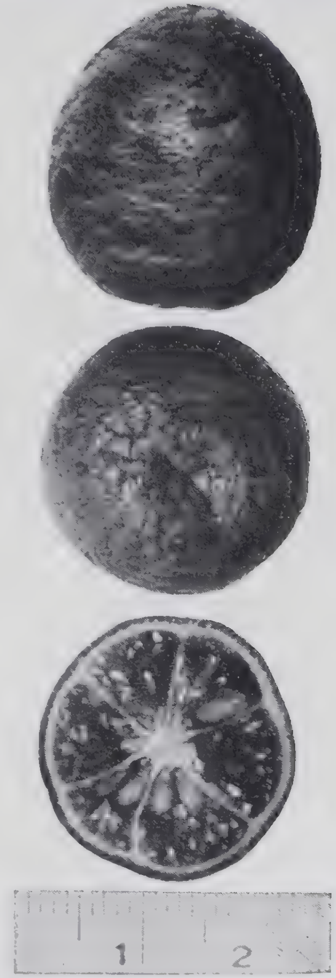

(*d*) *Citrus mitis* Blanco. CALAMONDIN.

(a) *Citrus histrix* DC. CABUYAO.

(b) *Citrus histrix* var. *torosa* Blanco. COLOBOT.



(c) *Citrusmicrantha* Wester. "Balincolong."



(d) *Citrus micrantha* Wester. "Samuyao sa Amoo."


A new way of preparing entomological exhibits.

*Table showing the degree of citrus canker affection in the citrus collection at the Lamao Experiment Station*—Continued.

| P. I. No.— | Botanical name. | Canker affection. | | | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | Serious. | Medium. | Slight. | Nearly immune. | Immune. | |
| 1953 | *Citrus pseudolimonum* | | v | | | | |
| 2496 | do | v | | | | | |
| 4226 | do | v | | | | | |
| 4836 | do | v | | | | | |
| 2525-1-2-3-4-6-7-8. | *Citrus southwickii* | | v | v | | | |
| 2517-1-2-3-4 | do | | v | v | | | |
| 2526-1-2-3-4 | do | | | v | | | |
| 2049 | do | | | | v | | |
| 4841 | do | v | | | | | |
| 920 | *Citrus vulgaris* | | | | v | | |
| 969-1-2-3-4 | do | | | v | v | | |
| 1011-2 | do | | | v | | | |
| 1011-3-4 | do | | v | v | | | |
| 1264 | do | | | v | v | | |
| 1848-2-3-4 | do | | v | v | | | |
| 1448-5-6 | do | v | v | | | | |
| 1453-1-2-3-5-6 | do | | v | v | | | |
| 1593-1-2-3-4 | do | | v | v | | | |
| 1638 | do | | | | v | | |
| 2662 | do | | | v | v | | |
| 2357-1-2-3-4-5-6 | do | v | | v | | | |
| 2385 | do | | | | v | | |
| 2511 | do | | | v | | | |
| 789-1-2-3-4-6-8-9 | *Citrus webberii* (Pl. VI, *a*, *b*) | | v | v | | | |
| 853 | do | | | | v | | |
| 892-2-3-4 | do | | v | v | | | |
| 892-5-6 | do | | | | v | | |
| 892-7 | do | | | v | | | |
| 896 | do | | | | v | | |
| 897-9 | do | | | v | | | |
| 2066 | do | | | | | v | From the east coast of Mindanao. |
| 2275-1-2-3-4-5-6-7-8-9-10. | do | | v | v | | | Fruit decidedly oblate, very juicy and of excellent quality for ade. |
| 2363-1-2-3-4 | do | | | v | v | | |
| 2363-5-6-7-8-9-10-11. | do | | v | v | | | |
| 3671 | do | | | | v | | |
| 4828 | do | | | | v | | |
| 5102 | do | | | v | | | |
| 5104 | do | | | v | | | From Bontoc; said to be of unusually good quality. |
| 5105 | do | | | v | | | Do. |
| 5698-1-2-4-5-6 | do | | v | | | | |
| 5147 | *Citrus webberii*, "Bontoc" | | | v | | | A variety from Bontoc reported to be of unusually good quality. |
| 5145 | *Citrus webberii*, "Mackie" | | v | | | | Do. |
| 897-4 | do | | | v | | | |
| 5699-10 | *Citrus webberii* var | | | | | v | Very distinct type. |
| 5699-7 | do | | | | v | | |
| 3383 | *Citrus* sp. near *webberii* | | v | v | | | Of Saigon origin. |
| 2266 | *Citrus webberii* var. *montana* (Pls. I, *a*; VI, *c*) | | | | v | | Fruit rather seriously affected. |
| 615 | *Aegle glutinosa* | | v | v | | | |

# A NEW WAY OF PREPARING ENTOMOLOGICAL EXHIBITS.

By D. B. Mackie, *Entomologist.*

In the latter part of 1913 the writer was detailed to prepare for the Philippine Agricultural Exhibit at the Panama-Pacific Exposition a display of insects of economic importance in this Archipelago.

Anyone who has ever had to prepare an entomological exhibit depicting the life histories of insect pests knows the difficulties of preparing them in an attractive manner and of still correctly showing the various stages of the life cycles.

From the experience obtained in the preparation of exhibits pertaining to economic entomology, the writer believes that the following are essential to success:

1. The exhibit must be artistically prepared to catch and hold the attention of visitors.

2. It must correctly depict the various species under consideration.

3. It must feature that part of the stage of its existence which makes for the economic factor.

4. It must be properly labelled and supplied with a concise description covering the development, feeding habits, and control, in order that it may be of educational value.

To meet these requirements in an exhibit of economic insects, is admittedly difficult, and it was with this in view that the writer undertook the work above mentioned.

After considering all known methods of preparing such exhibits, it was found that each presented difficulties that rendered its adoption impossible.

To add to this, the exhibit would have to be prepared in Manila, all ready to be shown at San Francisco, and would have to be on exhibit at the latter place for virtually a year.

Soft-bodied larval forms present the greatest difficulties, and while it is true that the larval skins can be inflated and dried, yet they lack much of meeting requirements.

Alcoholic specimens were bleached and the fluid became cloudy while some forms turned black. After exhaustive trials in preserving dry and in fluids the idea of showing the preserved specimens was abandoned.

A collection of plates prepared in water color suggested the idea of utilizing colored views for such forms as could not be shown in the original.

After a number of trials with various methods it was found that the colored views could be advantageously used in conjunction with the Ricker mount. A model was prepared showing the life history of *Attacus atlas* var. *lorquinii* Linn., including the eggs, cocoon, exposed pupa, male with folded wings and female with wings spread and the parasite. The larva was depicted by a colored drawing.

While the illustration (Pl. VIII) gives an excellent idea of the possibilities of this mount, results obtained were so satisfactory that it is believed that it is worth while to go into detail.

Before doing this it may be well to mention some of the disadvantages that this method overcomes: First, the soft-bodied forms, which are so impossible to exhibit to advantage otherwise, may be shown in all aspects and the species displayed most advantageously; second, species that are very small can be shown in the flesh beside a scale drawing that is sufficiently enlarged to attract attention, and the drawings can be enlarged to maintain a uniform size which helps immensely from an artistic standpoint.

Furthermore, the mount is artistic, compact, durable and conveys its own information to the visitor, the legend giving pertinent facts as to the life history, development, feeding habits, and control.

In preparing mounts, the first consideration is to decide upon the size of the mount and cut the paper to fit. The placing of the specimens comes next. In order to obtain the best arrangement, the specimens may be placed in the mount and shifted until they are satisfactorily grouped. When arranged, a pencil sketch should be made outlining the specimens and marking the location of the cuts. These cuts will vary according to the shape and size of the specimen.

The aperture for the eggs would be circular and about 15 millimeters in diameter. For the cocoon and twig to which it is attached, a cut the shape of the longitudinal section would be made. For the body of the spread specimen an eliptical disk would be cut out while cuts should be made along where the costal margins of the forewings would lie. This lessens the strain on

the specimen and allows the paper to come tight against the glass, the specimen standing out in better relief.

To show the coloring of the under surfaces of the wings the specimen can be shown hanging from a twig, wings down as in the act of waiting for the wings to become expanded and hardened. It is also necessary to make a cut along the costal margin of the forewing; the cut to receive the body will follow the body lines of the specimen and of the twig.

After the openings are all made such stages as can not be shown in the natural can be painted in water color.

The cotton of the mount is resilent enough to hold the paper close against the glass of the cover and also forms a soft bed for the bodies of the specimens and is yet firm enough to hold them in position.

The exhibit prepared for the Panama-Pacific Exposition comprised the following species:

*Attacus atlas* var. *lorquinii*, *Attacus ricini*, *Chalcosoma atlas*, *Xylotrupes lorquinii*, *Oryctes rhinoceros*, *Rhynchophorus ferrugineus*, *Papilio rumanzovia*, *Papilio alphenor*, *Prodenia litura*, *Locusta migratoria*, and *Accridium graminium*.

Unfortunately a part of the exhibit was packed with other materials going to Washington, which prevented its return to the Exposition until after the awards were given, thus leaving only twelve mounts to be presented in the competition.

Despite this fact the exhibit won the highest award given for an entomological exhibition, winning easily over the exhibits of other countries having a much larger display.

# A DISEASE IN CATTLE IN THE PHILIPPINE ISLANDS SIMILAR TO ANAPLASMA MARGINALE THEILER (1).

By William Hutchins Boynton, *Pathologist.*

The animals in which this disease was found were native cattle from Batan Island which is located some thirty miles from the northern coast of Luzon. In view of the fact that rinderpest has not been introduced on that island and that the animals therefrom are highly susceptible to that disease, these cattle are used at the Veterinary Research Laboratory for experimental work on rinderpest.

The animals arrived in Manila by boat from Batan Island on June 7, 1915. They were placed in a corral in the city of Manila until June 19, when they were purchased by the Veterinary Division, Bureau of Agriculture, for experimental purposes, brought to the Veterinary Research Laboratory at Pandacan on the aftenoon of June 19, and placed in quarantine with several other animals, their temperature being taken twice each day and their general appearance noted.

On the morning of July 12, 1915, cow 3929 showed a temperature of 38.6° C. The average temperature for fourteen other cattle kept in the same shed and under similar conditions was 37.8° C. The afternoon temperature of this animal was 39.6° C. Bull 3932 also showed a temperature of 39.7° C. Although these temperatures were higher than those of the other animals they were not high enough to cause rinderpest to be suspected. Their blood was examined for surra in moist preparations and found negative. This was 35 days after arriving from Batan Island and 23 days after being brought to the laboratory. On July 13 both of the above animals showed temperatures of over 40° C., and were immediately taken out of the quarantine shed and placed in the shed with sick animals. Their blood was again examined for surra with negative findings.

On July 15, 1915, bull 3939, which was in the quarantine shed, showed a morning temperature of 38.8° C., and an afternoon temperature of 40.8° C. This animal was immediately removed

and placed with the sick animals. Its blood was also examined for surra with negative findings.

On July 15, 1915, cow 3929 refused food and had a depressed appearance. On July 16, this animal presented a very depressed appearance but remained standing, its legs being spread out as if trying to brace itself to keep from falling; pulse was 106 per minute; its body was covered with flies which it made no effort to drive away. (Pl. IX, *a.*) Since surra could not be found and the animal did not present the clinical picture of rinderpest further blood examinations were made, and at this time the bodies similar to *Anaplasma marginale* were located, about 30 per cent of the red corpuscles being infected.

On July 17, this animal was in a stupor, the respiration was slow and sonorous, and it remained standing with its legs spread out and its body leaning against the stall. It appeared to lose consciousness with its eyes open, and start to fall, but would recover itself. (Pl. IX, *b.*) Pulse was 98 per minute and wiry; quite pronounced oedema was present under its jaw. The animal was covered with flies which it made no effort to drive away. There was practically no response on trying to rouse the animal. On the afternoon of the 17th, its temperature was 37.4° C., which is subnormal. As it was feared the animal would die during the night and as it was desired to perform the autopsy while the body was in a fresh condition, the animal was led out and killed. When led, this animal was very weak, moved with great difficulty, and had to be helped by a man on either side to keep it from falling; when standing it did not need any assistance, as it kept the legs well spread out for support. (Pl. IX *c.*)

Upon autopsy the blood was found to be very anemic having the appearance of slightly hemolyzed blood. All the visible mucous membranes were pale. There were epicardial hemorrhages at the apex of the heart. The endocardium was pale and bluish, and there was a light red clot in both ventricles. The flesh in general was pale and bloodless. The lungs were distended and very pale.

A marked gelatinous infiltration was present, extending along the upper part of the throat and under the lower jaw.

Practically all the lymphatics were swollen, and oedematous, exuding a watery serous material upon section. The fat covering the omentum and around the intestines was yellow as if discolored with bile. The gall bladder was markedly distended, containing thick green bile almost the consistency of jam. The liver was brownish yellow, with heavier yellow streaks in places.

This organ was also very friable, but not enlarged to any noticeable extent.

The spleen was enlarged to one-half again its normal size, and the pulp was soft and bulged out on the cut surface upon section.

The kidneys were congested and presented a rather blotchy appearance. The blotches were lighter in shade than the general substance of the organ.

The intestines were streaked with bile their entire length. The feces in the large bowel were hard and in some places covered

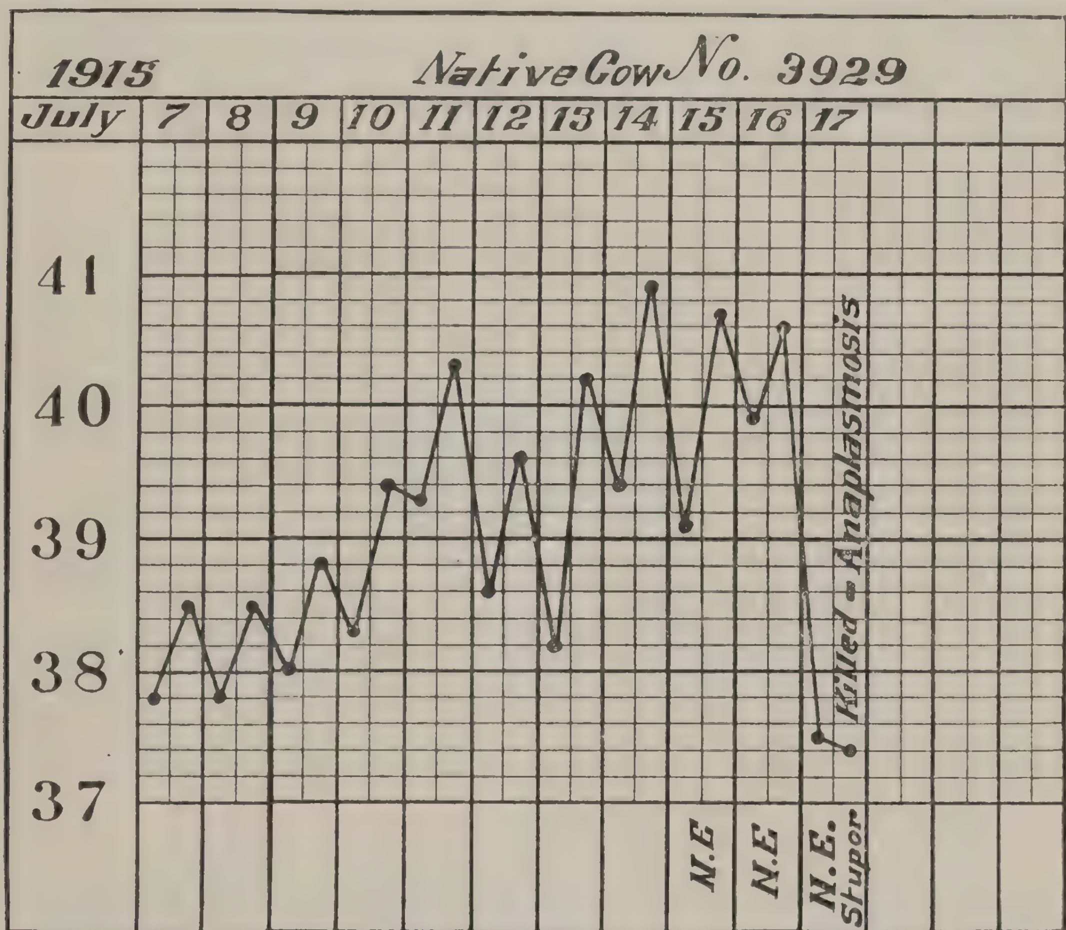



FIG. 1. Temperature Chart of Cow 3929.

with mucus. The fourth stomach contained watery bile-stained fecal matter; the mucous membrane was slate colored, and as far as could be noticed contained no hemorrhagic or congested areas.

The throat and region of the fauces were free from erosions or congestion.

The entire intestinal tract, except for being bile stained, was slate colored. The urinary bladder was markedly distended and contained yellowish-brown, slightly turbid urine. No signs of blood or hemoglobin were in evidence. The general appearance was that of marked anemia.

Tissues were taken from the heart, spleen, lungs, liver, kidney, fourth stomach and duodenum. These were fixed in sublimate acetic and sectioned.

Five cubic centimeters of heart's blood was immediately taken from 3929 and injected subcutaneously into bull 3926. The latter animal was kept under observation until February 29, 1916, and never showed any ill effects from the injection nor were anaplasma-like bodies ever found in its blood.

Bulls 3932 and 3939 showed a few anaplasma-like bodies in their blood, ranging from 2 to 3 per cent, but both contracted rinderpest after their removal from the quarantine shed and died of that disease.

The blood-smear preparations and sections of tissue were stained with Giemsa's, Wright's, Jenner's and Hasting's stains. The best pictures were procured with Giemsa's following the technique used by Sieber (2). "Cover glasses have to be cleaned well in alcohol, then a thin film of blood is spread on, and, with the smeared side downwards, they are thrown into hot sublimate alcohol (concentrated watery sublimate lotion two parts, alcohol one part). The preparations remain in this solution for two to twenty-four hours. Then they are taken out with small horn forceps, well rinsed, and, in order to remove the sublimate, thrown into a solution of 2 per cent iodide of potash (100 parts) and Lugol's solution (3 parts); rinsed again after ten to fifteen minutes, and in order to remove the iodine put into a watery solution of sodium hyposulphite (0.5 per cent). The preparations having become colorless by the solution of iodine (after five to ten minutes) are now carefully rinsed in water and fit for other staining manipulations.

* * * * * * *

"For Giemsa staining of the above-mentioned smears, diluted Giemsa lotion is used ($\frac{1}{2}$ to 1 drop in 1 ccm. aq. dist.). This liquid has to be changed several times during the first two hours, then the preparations are left in the solution for four to twenty-four hours. Then they are well rinsed and brought through the following:

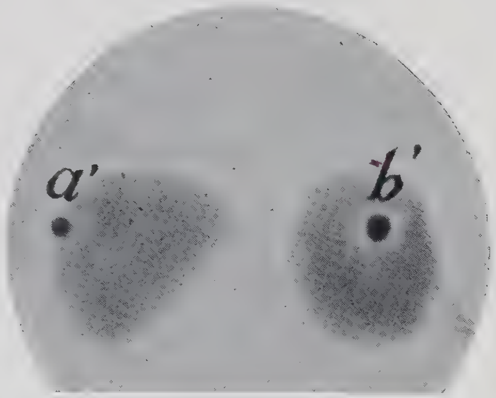
"Xylol 5, acetone 95.
"Xylol 30, acetone 70.
"Xylol 70, acetone 30.
"Xylol pure.

According to the degree of differentiation, the preparations are left for a longer or shorter time in the acetone liquids. The preparations are taken out of the pure xylol and placed at once in oil of cedarwood (not Canada balsam)."

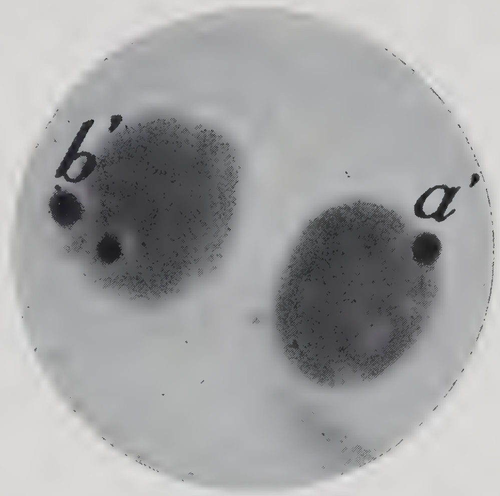
(*a*) Cow 3929 leaning against the stall with leg spread to keep her from falling. Last stages of questionable anaplasmosis.

(*b*) Cow 3929 in a semicomatose condition, respiration sonorous, pulse wiry, body covered with flies, legs spread to keep her from falling. Last stages of questionable anaplasmosis.

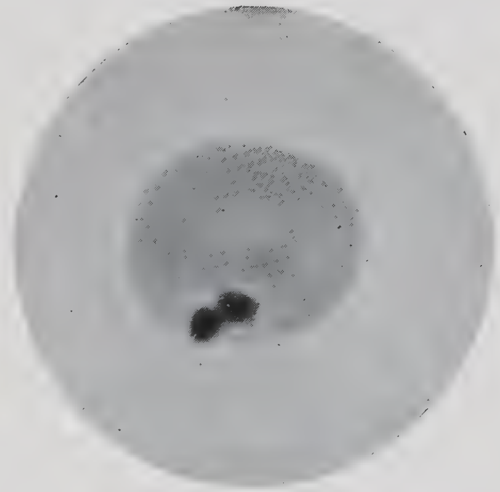
(*c*) Cow 3929 just before being slaughtered, body covered with flies, legs spread, oedema under jaw and throat. Animal had a subnormal temperature. Last stages of questionable anaplasmosis.



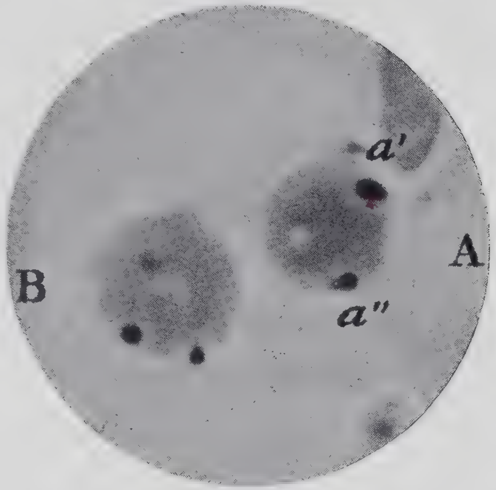

(*a*) Two red blood cells containing anaplasma-like bodies: (*a'*) *Marginale* type (Theiler); (*b'*) *Centrale* type (Theiler). Notice the halos around the bodies.



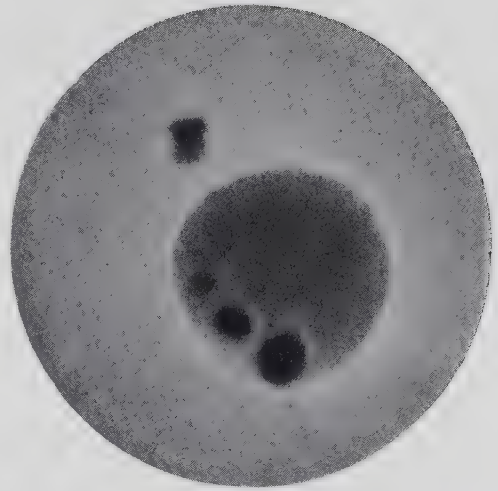

(*b*) Two red blood cells containing anaplasma-like bodies: (*a'*) *Marginale* type (Theiler), protruding slightly beyond the periphery of the cell; (*b'*) two bodies apparently shortly after division, one remaining on the margin and the other migrating across the cell.



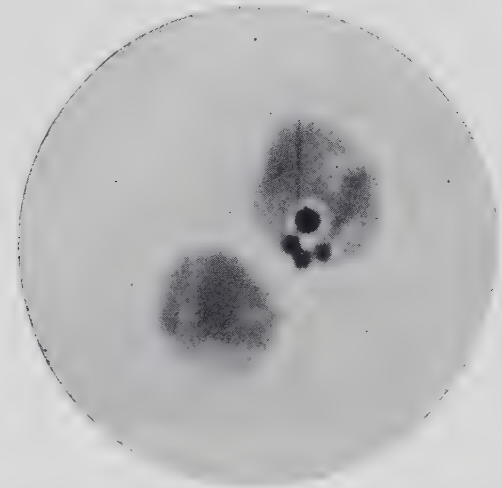
(*c*) A red blood cell containing a body which has almost completed division. Notice the halo around the bodies.




(*a*) Two red blood cells containing anaplasma-like bodies: (A) containing two bodies undergoing division, (*a'*) body becoming oval before division takes place, (*a''*) one body much larger than the other, division almost complete, giving the appearance of budding; (B) two bodies in a cell both remaining at the margin.



(*b*) A red blood cell containing three anaplasma-like bodies of varying size, giving the extremes in size ordinarily noticed.



(*c*) A red blood cell containing four anaplasma-like bodies, two showing unequal division and two equal division.

This was modified slightly by using 1 to 1,000 potassium carbonate solution instead of the distilled water in making up the stain. This causes the preparations to stain deeper.

Microscopic picture of the blood.
(Plates X and XI).

As was stated above, the blood was very anemic which made it difficult to obtain good even smear preparations.

In stained preparations the red cells were lacking in hemoglobin and had a great tendency to crenate no matter what precautions were taken to prevent this. As a rule the bodies were situated on the margins of the corpuscles. In some instances they protruded over or at least caused the corpuscle to bulge out from the margin. Where two bodies were present in one corpuscle, frequently one was situated on the periphery while the other would be nearer the center, in the center, or beyond the center, and in some instances they would be on the periphery of the corpuscle, one on either side. This would indicate that frequently after division one of the newly formed bodies remains at or near its original location while the other migrates across the corpuscle to the other side. In other cases they divide and both remain at the periphery on the same side of the corpuscle.

Frequently the newly formed bodies after division are of equal size; however, the reverse is quite common in which one may be much larger than the other. A few instances were noted where division was not complete, one being as much as three times the size of the other, the smaller giving the appearance of a bud protruding from the larger, similar to the condition noticed in yeast cells undergoing multiplication.

As a rule one or two bodies were found in an infected cell but four or even five in a cell were not of rare occurrence.

With Giemsa's stain the bodies take a purplish red color, staining very brilliant, and are easy to distinguish. They vary in size from 0.5 micron to 1.5 microns.

They stained uniformly and appeared to be composed of a mass of chromatin with no cellular substance. A slight halo is present around a majority of the bodies which may be due to the lack of hemoglobin in their immediate vicinity but this halo does not have the appearance of a lighter-staining body substance.

With Wright's stain the bodies appear smaller than with Giemsa's method. It may be possible that with Wright's method all the chromatin is not stained; however, a body structure could not be distinguished.

Morphologically they are spherical or have a slightly uneven border, thus making any definite shape impossible, but there is a general tendency toward being spherical. Undoubtedly their shape depends considerably upon the stage of development. If they are fully developed and have not reached the stage for apparent reproduction they are spherical with a smooth border. When they reach the stage for multiplication either equal or unequal fission takes place thus breaking the evenness of the contours and distorting the spherical shape. They may assume slightly triangular, slightly oval, or various uneven, spherical-like shapes. Those recently divided are as a rule spherical.

Theiler (1) in his extensive work on anaplasma states that *Anaplasma marginale* is transmissable only in blood containing corpuscles, as the organisms have lost their body plasma for which reason they derive their name, and have to exist in the cell protoplasm, making them a strict intercellular organism. He failed to produce the disease by injecting filtered blood, proving that there was not a stage in the development of the organism which was filtrable.

He also shows that the incubation period after the injections of blood containing anaplasma depends upon two conditions. If the amount of blood is large the incubation period is shortened and if the strain has been passed through several animals by injection the same result obtains. He finds this period to average between 16 and 40 days, usually in the neighborhood of 23 to 25 days.

He distinguishes two varieties of anaplasma, depending upon their location in the red blood cells, the severity of the disease, and the inability of one to confer complete immunity upon the other. *Anaplasma marginale* is located upon or near the periphery of the cell and the other *Anaplasma marginale* (variety *centrale*) is somewhat smaller and located near to or in the center of the corpuscle. It has not been noticed that *Anaplasma centrale* causes death either by direct inoculation of blood or by tick infestation while animals affected with *Anaplasma marginale* frequently succumb. An animal recovering from the *Anaplasma centrale* infection, when inoculated with the *marginale* variety, develops the disease, but in a much milder form than would otherwise be encountered, which proves that although there is not a complete immunity there is some protection provided.

The incubation period for this disease after tick infection is rather long and has a wide range varying from a few days under two months to a few days over three months.

Animals which were immune to *Babesia bigemina* could be infected with anaplasmosis either by means of ticks or blood inoculation which proved that *Babesia bigemina* afforded no immunity against anaplasmosis and in further experiments he proves that animals recovering from anaplasma infection were not immune to *Babesia bigemina* either by means of ticks or blood inoculation. He suggests that in inoculating with *Babesia bigemina* for the purpose of immunization it is just as well to inoculate with anaplasma at the same time. The inoculation period of *Babesia bigemina* is so much shorter that the animal will have ample time to recover before the anaplasma reaction takes place.

He has also proved that animals recovering from *Babesia bigemina* and anaplasmosis can easily be infected with *Babesia mutans*, which shows that no immunity is conferred either separately or by both together against *Babesia mutans*.

Theiler proves that two varieties of tick can transmit the disease, *Boophilus decoloratus*, or the blue tick, which also transmits *Babesia bigemina*, and the black pitted tick, *Rhipicephalus simus*.

Frequently a double infection of *Anaplasma marginale* and *A. centrale* are found in the same animal, this being especially true after tick infections.

The three cases herein mentioned are the only ones which have come to the notice of the writer during the past 20 months. Further developments of the disease have been awaited, in order to obtain a better insight concerning its etiology, modes of infection, pathology, etc., but with no success, which leaves this paper merely a narrative discussing three cases which gave pictures similar to those described by Theiler and by Sieber as anaplasma infection. This creates a doubt as to whether that disease really exists in the Philippine Islands, or whether these animals suffered from some other ailment which brought about the formation of these anaplasma-like bodies in the red blood cells.

On studying the literature it is found that bodies similar to anaplasma may be produced artificially. Very creditable work has been done by Dias and Aragao (3) in which instance they were able to produce anaplasma-like bodies in dogs, rabbits and guinea pigs by injecting them subcutaneously with small doses of phenylhydrazine. They were also able to produce a similar condition in rabbits by injecting them subcutaneously with small doses of nitrobenzol, a similar condition in dogs by injecting them subcutaneously with small doses of pyrogallic acid, and a

similar condition in calves by injecting them with a series of fairly large doses of trypan blue.

In considering these results there arises a doubt as to whether this was the infectious disease designated by Theiler as anaplasmosis or the result of some other infectious or noninfectious disorder from which the above-mentioned animals may have been suffering, thus causing the formation of these bodies in their red blood cells.

Annie Porter (4) has observed anaplasma-like bodies in the red blood cells of mice, canaries, swallows, martins, lizards, snakes, frogs, toads and sticklebacks, which are representatives of all the great groups of the vertebrates. These bodies were most prevalent in animals which were anemic.

Balfour (5) has found anaplasmosis in sick donkeys from Malakas on the White Nile and is led to believe they are true protozoan parasites.

Spreull (6) has also observed the marginal points in the blood of cattle in South Africa and declares his conviction that the marginal points are parasitic in nature.

Jowett (7) observed marginal points in the red blood cells of a cat which had been inoculated with a trypanosome infecting cattle in Cape Town, South Africa. This cat was suckling a kitten at the time and similar bodies were found in the blood of the kitten. He also found similar bodies in the blood of rats infected with this trypanosome and has noticed them in the blood of apparently healthy non-infected rats. He also states that "In the case of the trypanosome-infected, and consequently anæmic, subjects (both cats and rats) the bodies were, as a rule, more numerously present than in other animals which appeared healthy and which had not formed the subject of experiment. They were sometimes markedly noticeable in the blood cells of our experimental rats the day following the administration of a dose of antimony." Jowett in his paper quotes Bruce, Hammerton, Bateman and Mackie as having noted the occurrence of marginal points in cattle (especially calves) in Uganda. These investigators refer to these bodies in the following terms: "If these bodies really constitute a new and undescribed parasite, the discovery will be one of great interest. Bodies similar in every way to these are found, however, in healthy young rats, goats, calves, etc., so that it is difficult to believe at once in their parasitic nature. Rather would they appear to be cell inclosures due to rapid changes taking place in the blood, such as takes place in young animals or in anæmias."

## CONCLUSIONS.

1. Cattle Nos. 3929, 3932 and 3939 presented bodies in their red blood cells similar to *Anaplasma marginale* as described by Theiler and by Sieber.

2. Cow 3929 presented the symptoms and lesions of anaplasmosis as described by Theiler and by Sieber.

3. The heart's blood of cow 3929 was injected subcutaneously into supposedly susceptible bull 3926 and the blood had no demonstrable effect either physically or by blood examination upon this animal during a period of 226 days.

4. From the results obtained by various investigators and from the results herein cited nothing definite can be stated as to whether there is an actual infectious disease caused by a protozoan microörganism which Theiler classifies as anaplasma or whether these marginal points are merely secondary effects from various conditions.

5. There is a possibility that there is an infectious disease caused by anaplasma and that there are bodies formed in the red blood cells from various other conditions which are so similar in appearance and staining reaction to anaplasma that they can not be differentiated at the present time.

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# A SUMMARY OF THE WORK OF THE PEST CONTROL SECTION FOR THE YEAR 1916.[1]

By D. B. Mackie, *Entomologist*.

## THE LOCUST CAMPAIGN.

As hitherto, the work occupying most of the attention and time of this section pertains to the supervision of the locust extermination work. In this connection it is deemed advisable to call attention to the economy effected by the amending of the Locust Act.

During the fiscal year 1914 the cost of the locust campaign was $42,385.77. During that period the locust fund was administered under Act 2121 and 2190.

The year offers a good example of the working of the amended Act as it is the first complete year in which the Act has been in operation.

During the calendar year ending December 31, funds in the amount of $7,425 were allotted to assist the various provinces in their campaigns against this pest; of this amount $2,800 was spent in the uncultivated Government domain of the Mountain Province, where the labor employed was all furnished from the Ifugao and Kalinga rancherias along the Cagayan, Isabela, and Mountain Province boundaries.

Besides the cash allotments made, equipment of sheet iron, net material, shovels, and crowbars in the amount of $546 was distributed.

The diminution of the amounts furnished this year as compared with those of preceding years is largely due to the provisions of the amended act. These amendments provide that all persons between the ages of 16 and 60 inclusive, shall, in time of locust outbreak, render two days per week gratuitous service to the Government in the extermination of locusts. It was further provided that any one amenable to the law in the destruction of locusts, who for personal reasons found it inconvenient to render

[1] Submitted January 31, 1917.

the stipulated service, was privileged to redeem his obligation to the Government by the payment of $0.30 for each day that he failed to render such service. This provision has helped to overcome what is perhaps the greatest obstacle in the locust campaign. By its enforcement the Act provides automatically its own fund to defray, to a considerable extent, the expenses of the campaign. It stimulates a much greater interest in the campaign on the part of those who have paid for the redemption of their labor and they do not sit idly by and see the work drag on.

One point which while not new is worthy of more consideration is the great benefit to be derived from a closer supervision of the campaign, an excellent case of this being furnished during the year just past. Due to the transfer of inspectors to other divisions and the fact that the general elections were on, it became impossible to give the locust campaign the attention it merited. As a result, the infestation increased and from April 15 to July 15 it had spread from 35 to 114 towns, an increase of 79 towns, or over 300 per cent. The greatest increase was between May 20 and June 20, when the infestation increased in 30 days from 47 to 107 towns.

About the middle of July, inspectors were detailed and an organization was effected which brought the number of infested towns from 114 on July 15 down to 35 on October 15.

### THE WORK OF THE PROVINCES.

Most of the provinces have rendered excellent service and have handled their campaigns with little or no assistance or supervision from the Bureau of Agriculture. Others have received only suggestions. Noteworthy among the results accomplished by the provinces is that rendered in the non-Christian districts of the Mountain Province, especially in Kalinga and Ifugao. This is also true of Pangasinan, Tarlac, and Nueva Ecija. In the Mountain Province the locusts swarms were located at long distances from the rancherias, each of which sent its quota of men every week, thus keeping up a continuous campaign which has lasted throughout the year and which has been the most persistent ever conducted in that region as well as having given results that are astonishing.

The basic idea of this work, which has been carried out wherever possible, is to place the entire supervision of the work in the hands of the province, that Insular officials entering the field only when it becomes evident that the local authorities are unable to cope successfully with the situation. Experience has

shown, however, that it will be necessary to have at all time available inspectors experienced in locust destruction work, especially in the organization and placing of the forces. The main reason is that the provincial and municipal officials, who are responsible for the organization and supervision of the actual campaign, are elected every four years, thus, bringing into charge of the work men that are unfamiliar with the law and its application.

With inspectors available for use in any province it is often possible to check outbreaks that would otherwise become wide spread and serious.

Taken as a whole, the authorities of the different provinces, have, with few exceptions, coöperated with the Bureau in a very commendable way.

In all, field work has been conducted by Bureau inspectors in 11 different provinces in connection with locusts.

At present, all inspectors are concentrated in the district comprising the areas along the Tarlac-Nueva Ecija-Pangasinan boundary where a heavy infestation occurred in November. There is little doubt but that these swarms will be destroyed and that no locusts will attain their winged stage.

The locust situation is more encouraging than at any time since the establishment of the locust office.

The extermination of locusts is considered impossible, but the question of keeping them below the point of injurious abundance is entirely dependent on the degree of activity with which municipal officials are prepared to conduct their campaigns.

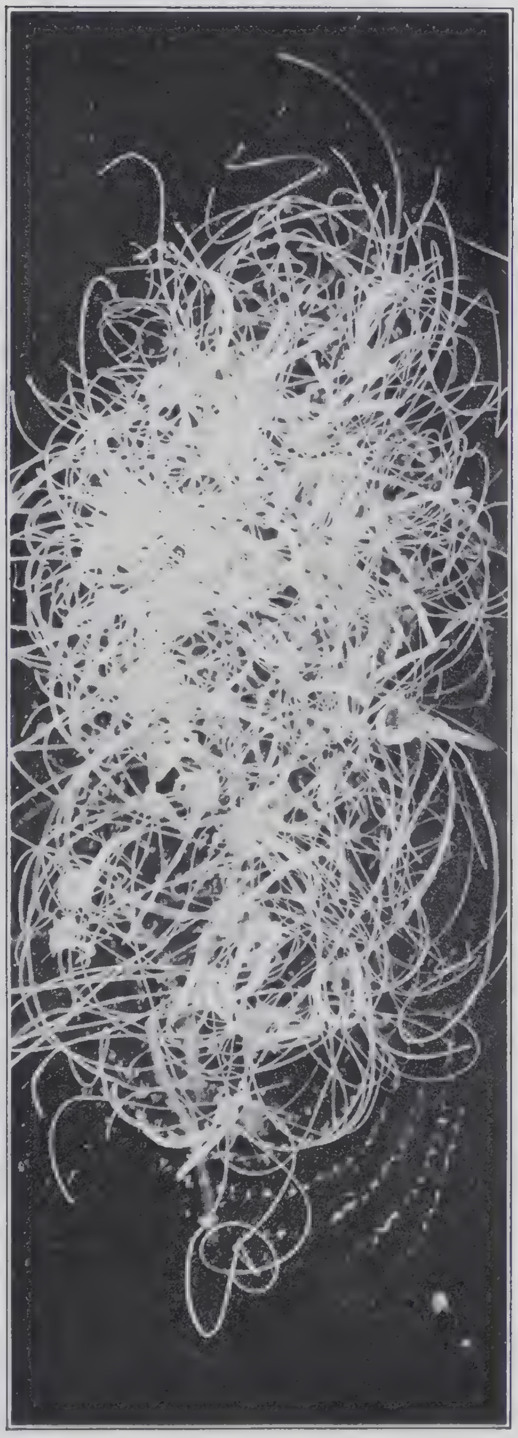
### INVESTIGATION OF DISEASES AND PESTS OF COCONUT PALMS.

The principal work in the investigation of coconut pests and diseases has been a continuation of the inspection of coconut groves to determine the presence and prevalence of budrot. Pl. XII.)

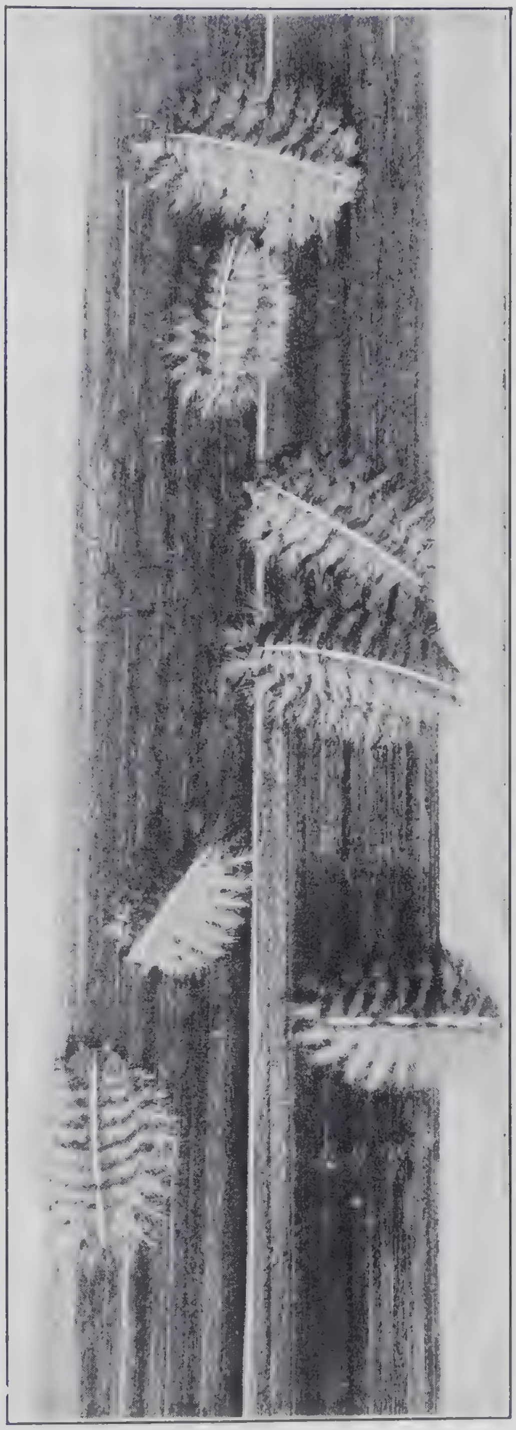
During the fiscal year under consideration, the work of inspecting the groves has been carried on to the full extent that the funds available would permit.

Speaking generally, it has been possible to keep an average of three inspectors in the field on this work throughout the year. The principal work, as before stated, was designed to furnish information as to the spread and prevalence of disease and, if possible, to ascertain the pathogenic agent and the means of distribution. In this connection, the results obtained have been most satisfactory and pleasing.

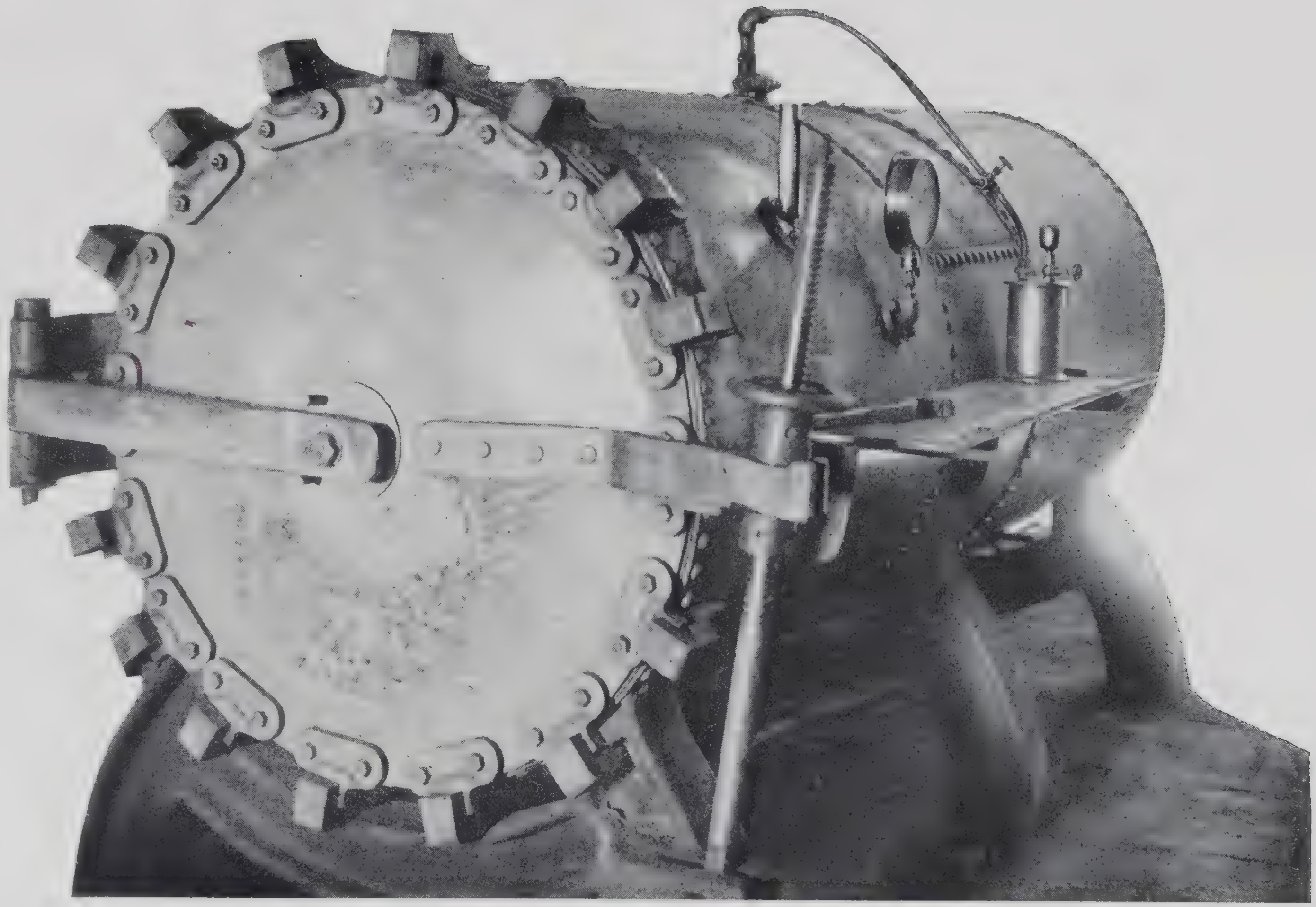
Flower spathe of coco palm showing spot of new infection with budrot.



(*a*) *Aleyrodicus destructor* Quaint. This is a coconut pest which has increased alarmingly during the past year.



(*b*) Larvae of *Thosea cinereamarginata*, Banks. Another pest of the coconut palm which has become very destructive in certain districts of the Islands.



Vacuum machine for freeing cigars from the tobacco beetle, *Lasioderma serricorne*.

Inspections have been confined largely to the coconut belt of central Luzon, including the Provinces of Tayabas and Laguna.

During the year, a total of 949,106 trees were inspected, of which 1,061 were found to be infected with budrot and were destroyed.

Practically each quarter of the past year has seen some innovation in the methods and scope of the inspection of the groves. At first this office simply notified the owners that their trees were infected and relied upon the owners to destroy them. Lately, as legislation came into force, notice was issued and a time limit set for the destruction of the trees.

Experience brought out the fact that it was practically impossible to effectually destroy diseased crowns of trees during the rainy season by ordinary methods. The Bureau undertook the work, first securing the owners' consent. This led to experiments with powerful gasoline torches to consume the diseased part. Results are very gratifying but still show room for improvement. Still further experiments are in progress, special large foundry torches operated under high pressure having been ordered from the United States.

The next change will be an amendment to the present regulations charging the Bureau of Agriculture with the destruction of the infected trees, thus providing for a much greater thoroughness in the manner of destruction, and a solving of the very difficult problem of serving the notice on the owners or men in charge of the diseased trees.

While as previously stated most of the work on budrot has been carried on in the coconut belt of central Luzon, yet reports have been received which point to the fact that the disease is much more wide spread than has hitherto been supposed. During the year under consideration ten provinces have reported its presence and requested the assistance of inspectors. In seven of these provinces, Laguna, Tayabas, Batangas, Pangasinan, Tarlac, Albay, Ambos Camarines, our inspectors have confirmed these reports. Misamis, Capiz, Samar, and Bohol have reported its presence but no chance has been offered for the confirmation of these reports through inspection by officials of the Bureau.

Research, in connection with this disease, includes the following:

1. Its distribution and prevalence.
2. Effect of meteorological conditions on its prevalence.
3. Research by the pathologist relative to the pathogenic agent.

4. Investigation of the role played by insects in its distribution.

Under heading number 1, a survey has been made of practically all of the coconut belt of central Luzon with an inspection of 2,284,518 trees by actual count, all trees having been individually examined. This survey has been conducted for the purpose of ascertaining the particular areas of infestation, and has included ten municipalities in Tayabas and thirteen in Laguna. The only remaining uninspected towns are Louisiana, Alaminos and parts of Nagcarlan, Majayjay, and Lilio, in Laguna, and Bolboc, Batangas.

This work is completed to the extent that the centers of infection have mostly been discovered.

(2) A survey of meteorological conditions has been made through the coöperation of the Weather Bureau showing the precipitation, relative humidity and annual distribution of the rains throughout the coconut belt, using for this, data obtained at the weather stations located within the coconut belt, together with special information on the subject collected by the Bureau of Science. All these data have been compiled and tabulated.

(3) Nothing being heretofore known as to the pathogenic agent responsible for budrot as it occurred in the Philippines, this phase of the work has been given due consideration. Dr. W. H. Boynton, pathologist of this Bureau, has kindly consented to assist in the work and has already prepared cultures from which it is believed the specific agent responsible for the disease will be found.

(4) Investigations are in progress to determine whether the presence of certain insect pests of coconuts have anything to do with the prevalence of budrot. For this purpose, inspectors keep a record of trees killed or badly damaged by both the rhinoceros beetle and palm weevils, special reporting forms being used for this work.

Supplementing this inspection, extensive field research is being carried on to determine the fauna present in diseased trees and those species which are attracted by and feed upon the infected parts. These investigations have already brought out the fact that the large palm weevil, *Rhynchophorus pascha* Bohem, is a persistent feeder on the decayed part of the diseased trees, beetles being recovered from practically every affected tree.

Additional research by Dr. Boynton has resulted in the isolation of the same bacillus as was obtained from the tissues killed by this disease. Present results, if confirmed, will be

far-reaching and will largely modify the present campaign methods.

The rhinoceros beetle continues to be the most destructive pest of coconut palms in these Islands. Investigations have been continued and include the special work covering its life history and the various measures that prove of value in its control. Its feeding habits have also been given consideration and a list has been prepared of the different palms attacked by it. To this work might be added the investigations conducted regarding its rôle in the distribution of budrot.

Palm weevils have for the past year been more numerous, if anything, than ever before. The two species *Rhynchophorus ferrugineus* Oliv. and *R. pascha* are about equally prevalent, though their distribution is often quite local. They easily rank second among the various major pests of the coconut palm. In connection with the transmission of budrot their rôle is being most thoroughly investigated, actual count being made of all infested trees, especially those trees which are infested both with these species and the disease. Laboratory investigations are still in progress to determine the life history and other data relative to their bionomics.

The work of this Bureau has revealed the fact that *Rhynchophorus pascha* is a much more active and persistent pest of the coconut palm than the smaller *R. ferrugineus;* investigations have shown that one grub of this species will, during its larval stage, gnaw its way from the base to the crown of a tree 14 feet in height.

Among other species not hitherto considered dangerous is the white fly, *Aleyrodicus destructor* Quaint. (Pl. XIII, *a.*) During the month of June an unexpected outbreak of this species occurred at Zamboanga. It was the most serious that has ever been reported, and as it was impossible to detail inspectors to study the pest, recommendations were made to the district governor. These were simple but drastic, being nothing more than cutting off the fronds bearing the colonies and burning them. This checked the outbreak. Fortunately the planters realized that the infested leaves would die, and were thus willing to destroy them to prevent the spread of the pest.

Two other provinces, Laguna and Misamis, having reported the presence of *Aleyrodicus destructor,* it seems to be on the increase. It is a species comparatively new to science, being first reported by the author from Oriental Negros. If it continues to increase at its present rate, it will, some day, become

a pest of major importance. Study of its life history and bionomics is now under way.

Another insect which has wrought considerable damage is a Limacodid, *Thosea cinereamarginata* Banks. (Pl. XIII, *b.*) Like the former, this insect is one that seems to have sprung but recently into the class of pests. While present in Luzon it seems to be innocuous, being held in check by its natural enemies. Yet in parts of Mindanao, especially in the district of Zamboanga, it has caused extensive damage entirely defoliating the trees throughout entire districts. Unfortunately, this is another pest which could not be given the much needed attention its importance merits, due to the lack of qualified personnel to make the necessary examination and recommendations. For several seasons it has defoliated the palms of this region.

Other pests which have been reported as attacking this palm have, with one exception, been either local in their distribution or have not caused extensive damage. They include the two species of Lepidoptera, *Padraona chrysozona* Plötz. and *Amathusia phidippus,* and the leaf-miner beetle, *Promecotheca cummingii* Baly.

The exception, while not of major importance, has, as far as can be ascertained, done considerable damage in the Nothern part of Palawan and on the Island of Dumaran. It is, like its relative, *Thosea cinereamarginata* Banks, a Limacodid, though smaller.

## WORK IN THE CONTROL OF THE TOBACCO BEETLE AND MOLD OF CIGARS.

The pricipal work on tobacco pests consists of investigations of means of control with regard to the tobacco beetle, *Lasioderma serricorne* Fabr., known locally as the "gorgojo," and the various molds. This line of investigation has resulted in more direct results than will perhaps any other work ever conducted by the office of pest control.

The completed investigation of the beetle includes a study of its life history and methods of control. The results accomplished are very noteworthy.

As indicated in the last report manufacturers have been unreasonably prejudiced against any treatment of their product in which any chemical was utilized. This attitude has greatly hampered the application of control measures. However, by persistent study, it has been possible to devise an apparatus (Pl. XIV) by means of which tobacco products could be treated

in such a manner as to kill all beetles, regardless of whether they were in the egg, grub, pupal or adult stage.

The process in question consists of heating the tobacco to a certain degree after which the air is pumped out till a 28-inch vacuum is registered by the vacuometer. The material being heated higher than the vapor tension point of water under this pressure, this causes the water content of all bodies comprehended therein to change to a gaseous form, and thus all insects are killed.

What this means to the tobacco trade can be understood from the following:

A tobacco manufacturer who equipped his factory with one of the machines brought out by this office in 1914 for use of vacuum with carbon bisulphide, reports that he has been able to secure one order for 25,000,000 cigars simply by reason of the fact that he could guarantee his product free from the beetle.

When it is understood that every million cigars pay an internal revenue tax of $3,000, the tax collected from one such order amounts to $75,000, or more than twice the annual amount available to run the entire pest control project for one year, inclusive of the $25,000 available for contributions and gratuities, the importance of this work can be realized.

While investigations relative to the treatment with heat and vacuum are completed, 14,000,000 cigars having been processed, it has been agreed that manufacturers should wait six months in order to hear from shipments made to the United States. One hundred thousand cigars were processed per day in order to demonstrate that the process was commercially possible.

Work on molds affecting tobacco was taken up at the request of the Collector of Internal Revenue during November of 1916. Investigations were immediately undertaken and a study of the various processes of manufacture of cigars was made in detail. These investigations were designed to find out the cause of the prevalence of mold and to furnish a satisfactory means of controlling it. All experiments and observations have shown that molds are caused by improper drying and the use of a paste in which starch is the basic compound. When damp this paste furnishes ideal cultural media for the common molds. Experiments showed that where the trouble was with the paste it could be readily controlled by the addition of salicylic acid, formalin, or boracic acid.

In general, investigations revealed the fact that in factories where mold was troublesome the entire process of drying the cigars was not dependable, and in order to settle forever the

question of moldy cigars it will be necessary to change the drying process in order to obtain permanent results.

It has been shown that the desired result can be brought about by several methods, though the two given preference are direct steam-heated rooms in which the temperature is constant, and what is known as the plenum process of forcing superheated air into a room by means of a centrifugal blower fan. This latter, while perhaps slightly more expensive to install, is, in all respects, the most dependable and in fact offers the ideal means of handling the product as the temperature is always under absolute control.

The data obtained have been forwarded to the Collector of Internal Revenue, and the matter has also been taken up directly with two different factory owners who have each agreed to put in a new drying system in accordance with the specifications of this office. One of these is completed and the other is under construction. The results obtained will form the foundation for a system of control well adapted to the conditions in the tobacco factory in Manila.

Extensive studies of the methods employed by the manufacturers of tobacco products in the Philippines and their relation to the presence or absence of pests has shown the Government the necessity of bringing about a uniform system of treatment of all export cigars.

The reasons for this are as follows:

(1) In the cigar trade in the United States, the Philippine product is simply classed as Manila, no differentiation being given to the various brands, which results in the cheaper, poorly made products giving to the better a bad name; (2) too large a percentage of the high-grade cigars show up badly infested with the beetle, and others that are improperly dried develop mold; (3) tobacco manufacturers are suspicious of each other and are not inclined to accept any innovations; (4) the remedy is simple; (5) it is effective; (6) the cost of installment is small as compared with the results obtained; (7) the cost of operation is low; and (8) the Government guarantees the product and should see to it that the manufacturers produce an article that will conform to a certain standard.

## SUGAR-CANE PEST INVESTIGATION.

The work on sugar-cane pest investigation has largerly been done by the assistant entomologist.

A cane borer, probably *Diatrea striatalis*, was noted in Laguna and Mindoro Provinces but was not abundant. The fact seems

to be in evidence that the species is controlled locally by some species of parasites, probably native to the region, which succeed in keeping the pest below the point of injurious abundance.

A species of *Derbinae,* identified as *Phenice moesta* Westw., has been particularly numerous in parts of Luzon and although it causes considerable damage by sucking the juice from the leaves, it is never reported by the local planters as being noxious, this discrepancy being in all probability due to the fact that the planters are unfamiliar with its habits and do not recognize it as the cause of the damage.

Two species of leaf hoppers have also been noted, each of which is held in check by natural agencies.

A number of sugar-cane diseases have been observed during the year, among which may be included a leaf spot, *Cercospora* sp., very abundant in Laguna, and reported from Negros and Mindoro, also a disease resembling the Sereh of Java and Fiji; Black smut, *Ustilago sacchari;* West Indian Rind fungus, *Melanconium sacchari;* Pineapple disease (*Thielaviopsis ethacetica*), a black rot and what is apparently a red rot (*Colletotrichum*). Due to lack of personnel, little has been done in the line of control work.

PESTS OF ABACA.

More pests have been reported affecting this crop during the past year than during any previous year in the history of the office.

What is perhaps the most serious pest is a disease which appeared in the vicinity of Catarman, Samar. Investigations were made by Dr. H. A. Edson, pathologist of the United States Department of Agriculture, and the writer. Examination showed it to be of bacterial origin; it created a crown rot which affected the central frond, gradually spreading laterally till the entire stem was killed, and then spreading from the parent stem to the various suckers in the stool.

It has been ascertained that the disease passes through the soil and enters through the roots killing them first. Control measures were recommended, which seem to have proved satisfactory.

From Paete, Laguna, reports of the death of a large number of plants from some unknown cause were investigated and found to be caused by a weevil, *Cosmopolitus sordidus* Germ. This is a species locally quite common among bananas and should it increase, it will become a pest the control of which will be a difficult problem, as its mode of living renders remedial measures impossible, control being possible only through the destruction of the affected plants.

Another outbreak of a disease affecting this crop has been reported from Cavite but to date its investigation has been impossible due to lack of personnel.

### INSECTS AFFECTING RICE.

There has been no serious outbreak of rice pests reported during the year. The stem borer, *Shoenobius punctellus* Zell., while generally present has not been reported as damaging the crop as in previous years.

Investigations relative to its control show that it is never present in numbers sufficient to cause damage in those districts where the entire plant is destroyed after harvesting, as is the case in some sections.

Experiments at hand picking the infested stems as soon as the head turns white have shown that the larvae can thus be destroyed and the pest considerably reduced thereby.

The work on the rice-bug, *Leptocorisa acuta* Thunb., has been limited to laboratory work on the life history supplemented by field notes. Interesting data obtained from field investigation conducted in connection with the Bureau's field tests of early maturing varieties of rice have shown that these early maturing varieties, especially when planted with these late maturing, are attacked to such an extent as to render the crop valueless and hardly worth harvesting. While this was in a large measure expected, the damage exceeded that anticipated. As long as early varieties are planted this will continue. Only one remedy suggests itself, that is, the delaying of planting of quick-maturing varieties in order that the entire crop will ripen at the same time, thereby preventing the pest from concentrating its damage on one variety.

The inspector in charge of rice investigation reports that planters in Tarlac Province consider this pest worse than locusts.

### INVESTIGATIONS RELATIVE TO DISEASES AND INSECT PESTS OF CITRUS TREES.

The attention of the Bureau of Agriculture was first called to the presence of citrus canker in the Philippines by Mr. Walter Swingle, of the Federal Department of Agriculture, in June, 1915. Since its introduction to the United States, it has caused a loss of $10,000,000 to the citrus growers and is not yet under control.

With the study of this disease as one of the major objects of his visit, Dr. H. A. Edson, plant pathologist of the United States Department of Agriculture, came to the Philippines in January, 1916.

Investigations for the purpose of determining the distribution and prevalence of the disease were conducted by Dr. Edson and the writer. Beginning with some of the most important citrus districts, the investigations were extended to some of the remotest districts.

In the Province of Batangas, which is the most important citrus-producing district of the Islands, the disease was found to be prevalent and also destructive on *Citrus nobilis* which is the species of the greatest commercial importance.

Inspection of the more remote districts included the district of the Catarman River, Samar, and the Mountain Province, including the five subprovinces of Kalinga, Bontoc, Lepanto, Benguet, and Ifugao.

The work in the Mountain Province was conducted by Dr. Edson, Dr. Yates, mycologist of the Bureau of Science, and the writer.

At the same time, Mr. J. T. Zimmer, assistant entomologist of this Bureau, was conducting investigations along the same line in Palawan, his work covering the south and west coast of this Island. In no case did he find evidence of canker.

A considerable part of the inhabitants of the Mountain Province and Palawan are non-Christian people, who are not acquainted with any citrus varieties other than those that are native to the districts in which they live and seldom, if ever, concern themselves with new or introduced species.

The object of this work in the more remote regions is to find out whether or not the disease is indigenous to the Philippines.

As a result of investigations which show that the disease does not exist except in isolated cases in the more remote districts, leads to the opinion that the disease is a more or less recent introduction. This opinion is concurred in by both Drs. Edson and Yates. A detailed account of these investigations has been published under the heading of "Observations on the Distribution of Citrus Canker," appearing in this REVIEW, Vol. IX, No. 4. Fortunately the disease does not seem to occur in a virulent form in the Philippines.

In addition to the field work mentioned above, the Bureau has conducted a number of experiments with spray compounds in an endeavor to ascertain the possibilities of controlling the disease by artificial means. This phase of the work has shown that certain compounds, especially bordeaux with the addition of a certain percentage of formaldehyde, exerts a powerful influence in controlling the disease and seems to warrant further investigation. Other work has been limited to a study of the life

history of the orange caterpillar, *Papilio alphenor,* and work with the leaf miner.

### PLANT INSPECTION SERVICE.

This branch of the service was established by his Excellency, the Governor-General, at the instigation of the Federal Horticultural Board of the United States Department of Agriculture. Its object is to guard against the introduction and spread of dangerous plant pests and diseases into and from the Philippines by providing for an inspection of all incoming and outgoing plant material.

The records of this Bureau show that during the year under consideration, 463 certificates were issued. This covers the inspection of 11,286 plants, 730 packages of seeds, 1,825 bundles of cuttings, bud wood, and cane points.

During the year ten species of insect pests have been intercepted on incoming shipments of plant material, as set forth in the following tabulation:

| Country. | Contents. | Pests intercepted. | Disposition. |
|---|---|---|---|
| United States | Seeds | | |
| Guam | do | | |
| Cuba | do | | |
| Java | do | | |
| | Plants | Hemilea vastatrix | Fumigated. |
| | | Coccidae | Do. |
| | Cuttings | do | Do. |
| Costa Rica | Seeds | Curculionid larvae | Destroyed. |
| China | Plants | | |
| | Cut flowers | | |
| Japan | Plants | Coccidae | Fumigated. |
| | Seeds | | |
| | Bulbs | | |
| British India | Seeds | Curculionid and Dipterous larvae; Mites. | Destroyed. |
| French Cochin-China | do | | |
| Mauritius | do | Pyralid larvae and moths | Fumigated. |
| Straits Settlements | do | do | Do. |
| Territory of Hawaii | Plants | Pineapple disease | Destroyed. |
| | Seeds | Bruchidae and Curculionidae. | Fumigated. |
| Japan | Plants | Aphides and Coccides. | Do. |
| Formosa | Cuttings | | |
| Madagascar | Seeds | | |
| Porto Rico | do | | |

To the end that this office might be prepared to install an up-to-date inspection service, the inspection services of the United States, Japan, Territory of Hawaii, and Canada, were studied by the writer during vacation leave. His itinerary included the ports of Nagasaki, Japan, Honolulu, Territory of Hawaii, San Francisco, New York, Washington and Boston, in the United States, and Halifax and Montreal in the Dominion of Canada.

In regard to apparatus for the handling of insect pests inter-

cepted through the inspection of materials, it is believed that this Bureau is supplied with the most up-to-date equipment in the Orient, the equipment being greatly improved by the addition of a large vacuum fumigator. The apparatus in question was designed by the writer for use in the plant quarantine office at the Singalong Experiment Station. The efficiency of this machine has been ably demonstrated. In October, the Bureau received a shipment of 40 sacks of Algeroba pods. Our attention was called to the fact that the seed had been badly infested with species of Bruchids and Curculionids, but that they had been fumigated six times before shipment.

Upon their arrival at Manila, it was found that they were virtually alive with both the aforementioned species, especially the former. The shipment was divided into two lots of 20 sacks each. Lot number 1 was subjected to a vacuum of 28 inches and strong carbon bisulphide gas introduced, then allowed to stand for one hour, after which the gas was pumped out and normal atmosphere allowed to enter. Lot number 2 was subjected to the same process, except that the time limit was shortened to one-half hour. To date no living individuals of the pests have been noticed in either lot.

## EDUCATIONAL PROPAGANDA IN CONNECTION WITH PEST CONTROL.

Experience gained during the past year has shown that this phase of pest control work is one that is worthy of much greater consideration than it has heretofore been given. Activities in this line consist of lectures dealing with the particular pest under consideration and delivered in the native dialect of the town in which the inspectors are operating. During the year lectures have been delivered on the tobacco worm, *Prodenia litura* Fabr.; the leaf hopper, *Idiocerus clypealis,* attacking the mango blossom; and a web-worm, *Tortricid* species, attacking the young leaves.

Special attention has been given this work in connection with the budrot campaign, the results obtained fully justifying expectations.

The whole-hearted response accorded Bureau inspectors in this work by the officials and planters of the infected districts has enabled inspectors of this office to cut down and destroy 1,061 diseased trees during the year, without a single protest. This is a record without parallel in the annals of the pest control work in the Bureau and furnishes the best evidence of success of this educational propaganda.

## WORK IN APICULTURE.

Experiments with honey bees have been continued and extended. During the year work has been done with three species: (1) The imported Italian bee, *Apis mellifica;* (2) Indian bee, *Apis indica;* and (3) the giant bee, *Apis dorsata.*

This branch of work has been of necessity much neglected: (1) Because the Bureau has no man on its staff that is experienced in apiculture; (2) pests and diseases of our staple crops have demanded every minute of our attention.

The imported *Apis mellifica* is still holding its own though the bees have received very little attention. They seem to stand the climate very well. During the rainy season a large number of workers are lost.

There is a disposition to rear queens in April, at which time there is very little in the way of forage, everything being dried up. This, however, can readily be corrected.

*Apis indica* yields readily to domestication, but while it has certain undesirable characteristics that might be overcome with careful handling by an expert yet they would militate to a considerable extent against the successful establishment of apiaries under Philippine conditions. Data collected on this species shows it to be distributed throughout the Archipelago, colonies of this species being noted at widely different altitudes, from 2,630 meters (7,900 ft.) in Benguet to sea level in Manila. This is of considerable interest, as it shows its ability to withstand much colder weather than was heretofore supposed. Temperature records secured at that time showed a minimum of 36° F., at 6 a. m., on January 1, 1916.

Compared with *A. mellifica,* this species is a poor honey gatherer but it will well repay any care bestowed upon it. A swarm would be a valuable adjunct to a coffee plantation for fertilizing the blossoms. The drawbacks are, as before stated, that it does not gather much honey, and it is inclined to abscond from the hive on slight provocation, especially if the hives are not well protected from ants and lizards.

From the results obtained, however, it is believed that further study of the possibilities of this species would well repay for the time spent.

The work with the giant bee, *Apis dorsata,* is in a way the most interesting. Experiments undertaken by this Bureau with this species are believed to be the first in the Philippines in which the swarms have been actually caught and hived. While this species is without doubt our best honey maker and yields a large

amount of excellent wax, it has certain characters which will probably make its domestication exceedingly difficult. First, it is exceedingly pugnacious and on the slightest provocation will attack anything molesting it. The dangers to anticipate from this habit are decidedly enhanced by the magnitude of the swarms and the virulence of the sting. Colonies of these species often contain as much as 30 liters of bees. Secondly, it builds its single-comb nest in open places, attaching them to a large branch of some tree, the workers covering and protecting the comb from the weather and guarding it against intruders. Among the advantages to be derived from its domestication are that it thrives well in any part of the Archipelago. It is perhaps the best honey maker of all bees, likewise, it is the species from which the beeswax of commerce is obtained. Although attempts to establish them have resulted in failure, considerable data has been secured, as well as specimens of the queen,which has never before been accomplished. Also experience has been gained as to the best time and manner of capturing the swarms and the means of preparing them for the hive.

Notes made regarding the distribution of this species show that it has a wide range, practically the same as *A. indica.* Colonies have been noted at all altitudes from sea level to 6,500 feet. At this height the nights are cold and frost often occurs from December to March. A peculiarity of the species is that it is most active about dusk and works until eight or nine o'clock.

It is believed that it could be introduced into the Gulf region of the United States and would be able to withstand the climate and would prove a valuable introduction.

### EXPORTATION OF USEFUL INSECTS.

This is a form of reciprocal courtesy which should rather be regarded as a remunerative investment.

During the year a considerable number of parasite species were shipped to the United States, the authorities there being exceedingly grateful for the service.

It becomes apparent, year by year, that the Philippine Government, by aiding other countries in this way, not only performs a courteous and helpful service to others but at the same time most emphatically benefits itself since reciprocal service of a similar kind is willingly and courteously rendered.

### LABORATORY WORK.

This line of work, due to lack of personnel, has not received the attention its importance merits.

The services of one assistant have been employed in rearing pests and in preparing data on the life history and development of the pests of the various agricultural crops. A considerable addition has been made to the Bureau's collection which now totals over 25,000 specimens. All laboratory work is supplemented with field notes, thereby enabling the securing of data on the actual bionomics of the insects, which is virtually the key which enables the suggestion of proper control measures. As the data are completed, drawings are prepared, illustrating the various stages of development, which are utilized in the illustration of articles and the preparation of lectures in the educational propaganda.

### UNCLASSIFIED WORK.

As always happens, much work has been done in the various branches which cannot be classified. The unnoted and at the same time laborious and necessary work of inspecting kitchen gardens, ornamental plants, shade trees, and houses for various pests and vermin, has occupied more or less of the time of technical men, which could ill be spared.

In many cases, inspectors have personally supervised the work; in others suggestions only have been offered.

What is perhaps the largest item on this schedule is the supplying of poisons for the destruction of rats and biting insects. In this connection, twelve provinces have been supplied with arsenical preparations which in all aggregate 130 kilos; white arsenic for rat poison, 98 kilos; and lead arsenate for insect pests, 32 kilos.

Under this heading may be listed investigations as to the possibility of commercializing the skin of the large pteropine bat. A knowledge that some 8,000 skins of this bat are annually imported into the United States for millinery purposes led to the idea that it might be possible to secure a diminution of this pest by commercializing its skin.

Information received by correspondence shows that furriers are willing to take skins in large numbers offering prices from 16 to 25 cents gold each; one firm offered a flat rate of $220 per thousand. This is a matter which is worthy of consideration and suggests a means of controlling this destructive pest.

### ACKNOWLEDGMENTS.

This report would be incomplete without some acknowledgment of the assistance received from outside sources.

The Bureau is under lasting obligation to the Philippine Constabulary for the great service rendered by the officers and men

of that organization in the work of locust destruction. Of special value has this work been in patrolling those portions of the public domain where the presence of the pest was suspected and in verifying reports as to the condition of the pest in the infected districts.

Acknowledgment is also due to the Manila Railroad, whose liberal attitude and a desire to coöperate has prompted them to issue free passes on all lines to inspectors of the Bureau of Agriculture engaged in locust destruction. By these passes, our inspectors are enabled to cover a much greater range of territory than would otherwise be possible.

To the Federal Department of Agriculture and the plant quarantine officials of the State of California, it is also desired to make due acknowledgment for the great assistance given the writer in studying the system in vogue in plant inspection service; also to the quarantine officials of Hawaii, Japan, and the Dominion of Canada.

# A CONTRIBUTION TO THE HISTORY OF THE MANGO IN FLORIDA.

By P. J. WESTER, *Horticulturist in Charge of the Lamao Experiment Station.*

The State of Florida in the United States of America was comparatively late in introducing the mango, but within the short space of time it has been in cultivation there this fruit has there been the object of great attention, and some of the greatest advances in the vegetative propagation of the mango have been made in Florida.

In 1915 Rolfs published a bulletin entitled "Mangoes in Florida" in which he made an attempt to classify the mangos introduced into the State up to that time. When connected with the Subtropical Garden in Miami, Florida, the writer made an effort to obtain information relative to the introduction of the various main types. The data assembled, some of which have never appeared in print so far as the writer is aware, are presented herewith in the belief that they will prove of interest to many who are familiar with the history of the mango and its spread from its home in the East throughout the Tropics and sub-Tropics.

The earliest introduction of the mango into Florida appears to have been made in 1833 by Henry Perrine.[1] According to an extract from the postcript of a letter to the Secretary of the Treasury, dated Campeche, Mexico, Sept. 12, 1833, Perrine sent to Florida, "*Persea gratissima, Mangifera domestica* (*indica*), *Annona squamosa, Annona muricata, Mammea americana,*" etc., but after Perrine's death in the massacre of Indian Key, the trees perished owing to neglect, war and fire, and many years elapsed before another attempt was made to introduce the mango.[2]

The second and successful introduction was made to the lower east coast by a Dr. Fletcher, who, in 1861 or 1862, planted seeds on what was once called the "Gilbert place," situated about

[1] 25th Congress, 2d Session, Rep. 564, 1838.

[2] U. S. D. A., Div. of Pomology, Bul. No. 1, 1887, p. 28.

Mango "Turpentine" in Snapper Creek Hammock, Cocoanut Grove, Florida.

Mango "Mulgoba," in Mangonia, Florida. The first grafted Indian mango tree successfully introduced into Florida.

one-half kilometer or more from the mouth on the south side of the Miami River. From these seeds two mango trees grew and attained a large size, one of which was still alive and in bearing in 1910. Few people are now alive who remember these trees when they were in their prime and well cared for, and some say that both trees fruited, while others assert that only one tree was fruitful. Be that as it may one tree has long since perished, but the other, which many years ago was blown down by a hurricane, sent up sprouts from the fallen trunk, which had grown to trees of considerable size, and which notwithstanding the unfavorable conditions under which they existed—the surrounding land having been abandoned and allowed to grow up to forest—were still in good condition in 1909 and a few years previous to that year had been bearing annual crops of fruit. Unfortunately the writer did not obtain the information relative to the history of this tree until after the fruits were gathered in 1908, since when there were no opportunities to obtain fruits, but judging from the general habit of the tree, the foliage and the seeds examined, this tree was in all probability the parent of the so called "No. 11 mango" of southeast Florida. Taking it for granted that the sister tree was sterile, this was unquestionably the first mango tree to fruit on the mainland of the State.

In 1868 or 1869, O. P. Barnes and T. W. Foulkner planted seed in the Snapper Creek hammock south of Cocoanut Grove; of the trees grown, three still remained in vigorous health and produced more or less abundant crops of fruit annually until in 1909 when they were last seen by the writer. The largest of these trees in 1909 measured 160 centimeters in circumference at a height of 30 centimeters above the ground and was estimated to be about 14 meters in height with about a like spread. (Pl. XV.) These mangos are of the "Turpentine" type, and a large majority of the numerous seedling trees of this type growing on the lower east coast are probably descendants from these trees, although in the last fifteen years, as communication with the West Indies has been rendered more easy and rapid, seeds of the same type may have been introduced later from various sources.

In 1885, A. C. Richards obtained mango seeds from Key West which were planted on the "Wagner place," located about 2 kilometers northwest of the Courthouse in Miami. From these seeds two trees grew to a considerable size and were in good condition as late as in 1909 when they were last seen by the

writer. The fruit is of the "Bombay" type, and these trees are probably the parents of most of the younger trees of this type growing on the east coast of the State.

The "Manila" or "Filipino" mango was introduced into the State in 1900 by Gary Niles, who shipped a barrel of fruit of this type from Havana, Cuba, to Miami. The seedlings grown from this importation were scattered to some extent throughout the vicinity of Miami and Cocoanut Grove but most of the plants were set out in orchards by S. A. Belcher, Miami, and Orange Pound, Cocoanut Grove, and they fruited for the first time in 1907 and several bore fruit of very good quality. Budwood of the parent tree was also imported by Mr. Niles, but the trees obtained from this material had not fruited in 1910.

According to Reasoner [1] the mango was first introduced successfully on the West Coast of Florida in 1877, by W. P. Neeld, Point Pinellas.

The first attempt to introduce grafted plants from India into Florida was made in 1885 by the Rev. D. G. Watt at Pinellas. Of the eight plants received all but two were dead, and these were making good growth when the freeze killed them in 1886.

The first successful importation of grafted East Indian varieties into the United States was made in 1889 by the Division of Pomology of the United States Department of Agriculture, these trees being sent to fruitgrowers on Lake Worth. All the trees except one, a Mulgoba, sent to the Rev. Elbridge Gale, West Palm Beach, died from weakness, or were killed in the freeze of 1895. This tree fruited for the first time in 1898, and has continued to fruit although injured several times by subsequent freezes. (Pl. XVI.) The Mulgoba variety is now well disseminated in Florida, Porto Rico, and Cuba.

Since 1889, the Office of Foreign Seed and Plant Introduction, Bureau of Plant Industry, United States Department of Agriculture, has taken the lead in the introduction of improved mangos into Florida. Many varieties have also been imported by Mr. E. N. Reasoner, Oneco, and Mr. John B. Beach, West Palm Beach, Florida.

The mango introductions since 1905 may be readily traced by consulting the Inventories of "Seed and Plant Introductions" made by the Bureau of Plant Industry, United States Department of Agriculture. The Annual Proceedings of the Florida State Horticultural Society, and the current agricultural papers

[1] U. S. D. A., Bul. No. 1, Div. of Pomology, 1887.

published in Florida, also contain information of interest pertaining to the mango.

In the asexual propagation of the mango notable advances have been made in Florida. Mr. Geo. B. Cellon, Miami, successfully patch budded the mango in 1900 or 1901, and he has since employed this method in his nursery operations with the mango, which probably are more extensive than those of anyone else.

From 1904 to 1908 much time was devoted by the writer to experimental work in budding, grafting and inarching the mango at the Subtropical Garden in Miami, and while incidental shield as well as patch buds were successful, the results as a whole were disappointing. In 1909, Mr. Orange Pound, Cocoanut Grove, was the first to successfully shield bud the mango on any considerable scale. His discovery of the importance of the similarity in age and appearance in scion and the stock at the point of graftage is unquestionably one of the most notable in the history of the evolution of the vegetative propagation of the mango.

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NOTE.—The plates accompanying this paper are published through the courtesy of Mr. David Fairchild, Bureau of Plant Industry, U. S. Department of Agriculture.

# NEW DISEASE OF THE PINEAPPLE REPORTED.

By D. B. MACKIE, *Entomologist.*

The attention of the Bureau of Agriculture has been called to the presence of a disease affecting pineapples in the Archipelago which, if allowed to spread and become distributed, may prove a serious menace to this crop. The disease has been noted on the varieties known as Smooth Cayenne and Queen. It causes a hypertrophy of the tissues, which gives them a rough corrugated appearance. It has also been noticed that the suckers prepared for shipping which show these same corrugations often develop a heart rot, which causes the entire heart to become shiny and easily pulled out. Whether this rot is characteristic of the disease is not yet known, but it has been noticed on about 10 per cent of the suckers which also showed the corrugations.

In Hawaii there is a disease of pineapples which the Territory has subjected to a local quarantine. Rule XVIII of the territorial regulations states that all persons and corporations are prohibited from carrying, transporting or shipping from the islands of Kauai or Oahu any pineapple, fruit, plant, or sucker, and no pineapple fruit, plant, or sucker from Kauai or Oahu shall be allowed to land at any port in the territory. For a violation of this regulation a fine not to exceed $500 is imposed.

Correspondence with the Hawaiian authorities leads this Bureau to believe that the disease which has been reported from Biñan, Laguna, and from Pinelands, Nueva Ecija, is the same which has proved so troublesome in the Hawaiian Islands.

As little seems to be known of the disease, affected plants should be pulled out and burned, also particular care should be exercised to see that no infected suckers are used for propagation or for distribution.

While the pineapple can hardly be termed a commercial crop in the Philippines, one company cultivates it on an extensive scale and has proved that its culture is a commercial possibility.

Plate XVII gives an idea of the appearance of diseased stock.

(a) Diseased leaves of pineapple showing corrugations.

(b) Diseased pineapple sucker showing heart rot.

# A STUDY OF THE ROOT SYSTEM OF THE SUGAR CANE AND ITS APPLICATION TO THE PRODUCTION OF RATOON CROPS.

By Cleve. W. Hines, M. S., *Sugar Technologist.*

The production of ratoon crops is entirely dependent upon the underground portion of the previous plant and the importance of each planter possessing a thorough knowledge of the structure and characteristics of this part of the plant cannot be overestimated.

The question is often asked as to how many ratoon crops may be successfully harvested from the land of a given plantation. It is obvious that in order to intelligently answer this question a careful study must be made of the conditions that obtain. It is thought by some planters that the climatic conditions, the soil fertility, drainage, irrigation, etc., are the only factors governing this point but when it is observed that on the majority of plantations in a given district little or no success is attained in the production of ratoon crops while in the same community other planters are able to ratoon their cane almost indefinitely, it is apparent that something more than the above-mentioned factors exercise a governing influence on the production of ratoon cane.

The present investigation of the root system of the sugar cane was made with a view to obtaining special information on this subject in order to formulate plans of value in the promotion of ratoon crops. It was started eight years ago on plantations of Porto Rico, Louisiana and Mexico, and has been continued at the three experiment stations of this Bureau and on various plantations of the Archipelago, where upward of four hundred varieties of cane were under observation. There were represented in this cane all of the stages of growth from newly planted cane to the twelfth ratoon.

*Method of propagating plant cane.*—It is the usual practice among planters of this country to propagate sugar cane by the use of cuttings or points which usually contain from two to six good eyes or buds from which the young plant emerges. In

subtropical countries it is necessary to use the main stalk, as the top would be too immature on account of the short growing season. This method of extending the area, known as vegetative propagation, invariably gives new cane with the same characteristics as the old plant except in the case of bud variations which, however, rarely occur. When it is desired to produce new varieties and thus improve the quality of the cane, seed is planted; but with either method of propagation a stool of cane is produced which may contain anywhere from a couple of stalks to perhaps a dozen or more. The origin of the numerous stalks where once existed only a single bud or a single tiny seed naturally proves of much interest and importance.

FIG. 2. View of a cane point after it had been subjected to a soaking for thirty-six hours and had remained in a heap with other points for twenty-four hours more.

Figure 2 shows a "tip" or "cane point" after it had been subjected to a preliminary soaking to induce the swelling of the buds and the spreading of the woody tissues of the point. This procedure also in a measure dilutes the sap that is normally contained in the dry "point" and permits its ready flow from cell to cell to feed the young buds until rootlets are put forth which secure plant-food material from the soil. In case the cane is to be planted on moist land or land that is to be irrigated, the preliminary soaking is sometimes dispensed with and the same general results are obtained provided there is sufficient moisture present in the soil. When the points are subjected to the soaking process after which a fairly warm temperature is maintained the buds will develop very rapidly and also the rudimentary rootlets at the joints will make a good start. The points then go through a process known in many tropical countries as "husking." During this operation the leaf-sheaths are removed thus permitting the buds to push forward unobstructed. Figure 3 is a view of a point after the leaf-sheaths were removed and the point was ready for planting.

It will be observed that the buds near the top end of the point have been developed to the impoverishment of those at the lower end. This is a natural condition of affairs which is explained

by the fact that the sap flows in that direction and consequently those buds will be fed at the expense of the ones near the lower end. Another reason for this condition is that the tissues of the point near the upper end are new and quite often entirely undeveloped which is in great contrast to the woody and more matured portion at the lower end. It will be noted further that only roots have developed in this lower portion and these will later serve the purpose of assisting in securing plant food for the young plant. When the second point is cut from thoroughly matured cane there are usually less favorable chances for the development of the buds than is experienced with the buds at the lower part of the first and when still others are taken the germination is usually quite low (see Fig. 4). The case is quite different, however, when unripe or immature cane is used for planting. In this case it is possible to secure a number of points and if the cane is sufficiently young the entire stalk except the extreme top may be used. Indeed this latter system is quite generally practised in subtropical countries, particularly in Louisiana, where the cane never reaches full maturity because of the short growing season. But even in those countries it is customary to sever the stalks at least once before they are covered with soil in order to prevent the sap from rushing in the direction of the top and permitting those eyes to develop to the starvation of the ones near the lower portion.

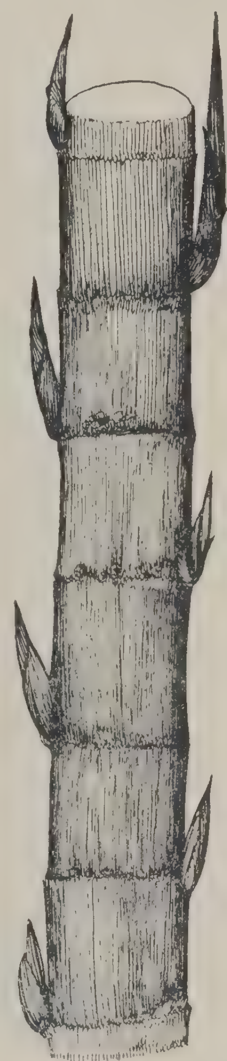

FIG. 3. View of the cane point shown in Fig. 2 after the leaf-sheaths were removed.

It is a practice on some plantations to cut the top point high enough to permit the uppermost growth or top to remain. This is an extremely bad practice since the top bud is undeveloped and in a growing state and consequently it will push forward very rapidly even during the soaking of the cane, thus using practically the entire sap of the point while the buds on the side of the point are left undeveloped. With the planting of such points there will result only small stools of cane and usually a poor stand as well, since the end bud which is covered with a leaf-sheath cannot so readily throw out roots and draw its plant material from the soil. Hence the plant is quite likely to perish

unless extremely favorable conditions prevail, notwithstanding the fact that the top bud made a more rapid development during the early period of growth than was experienced with the side buds on more mature points.

It will be interesting to follow the changes which take place from the time the cane point or tip is removed from the growing plant until a complete stool of cane is developed and from this time to the development of ratoon crops.

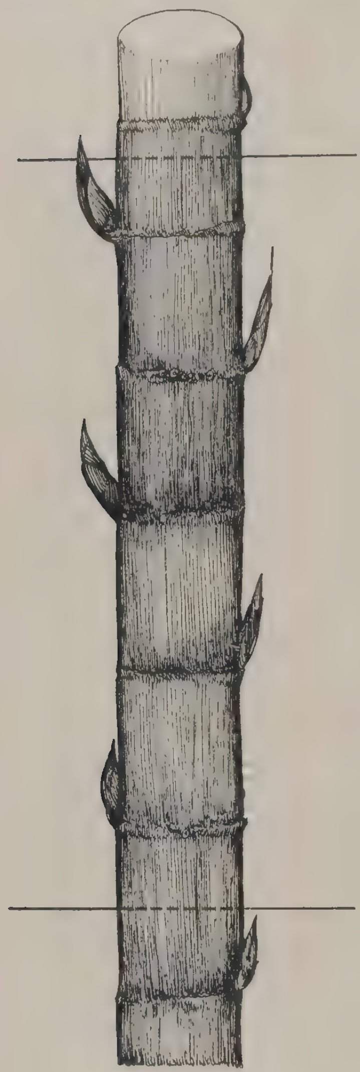

FIG. 4. View of cane point which had been improperly cut. This point could have been improved by cutting it as indicated in the drawing.

When the points were removed from the growing cane, the buds were small and undeveloped. Some moisture was later lost in the point before it was transported to the place of soaking. The soaking increased the weight of the point, softened the partly dried tissues, refreshed the buds, and reduced the gravity of the sap contained in the point so that it might readily flow among the plant cells. Since the points were well supplied with plant material, the germination portion developed very rapidly. During this period the buds sometimes push forward as much as 4 or 5 centimeters. An analysis of the liquid contents of the point indicates that among other organic compounds it contains a certain amount of sucrose and glucose or invert sugar, and a quantity of organic acids. The amount of each of these substances present depends upon the variety of the cane and its degree of maturity. After the point has been planted for some time, it is found that the percentage of organic acids is greatly increased, and the percentage of sucrose decreased forming first invert sugar and later organic acids while the actual quantity of invert sugar may be either greater or less than it was at the time of planting depending upon the particular time when the analysis was made and the rapidity of the enzymic action. While a small percentage of the mineral substances contained in the original point which were soluble or later dissolved in the

juice during the decomposition of the tissues of the point have been removed, yet the major part of this material is secured from the soil and the rapidity with which the tissues of the new plant are developed after the plant becomes large enough to rely entirely upon the soil and air for its plant material will

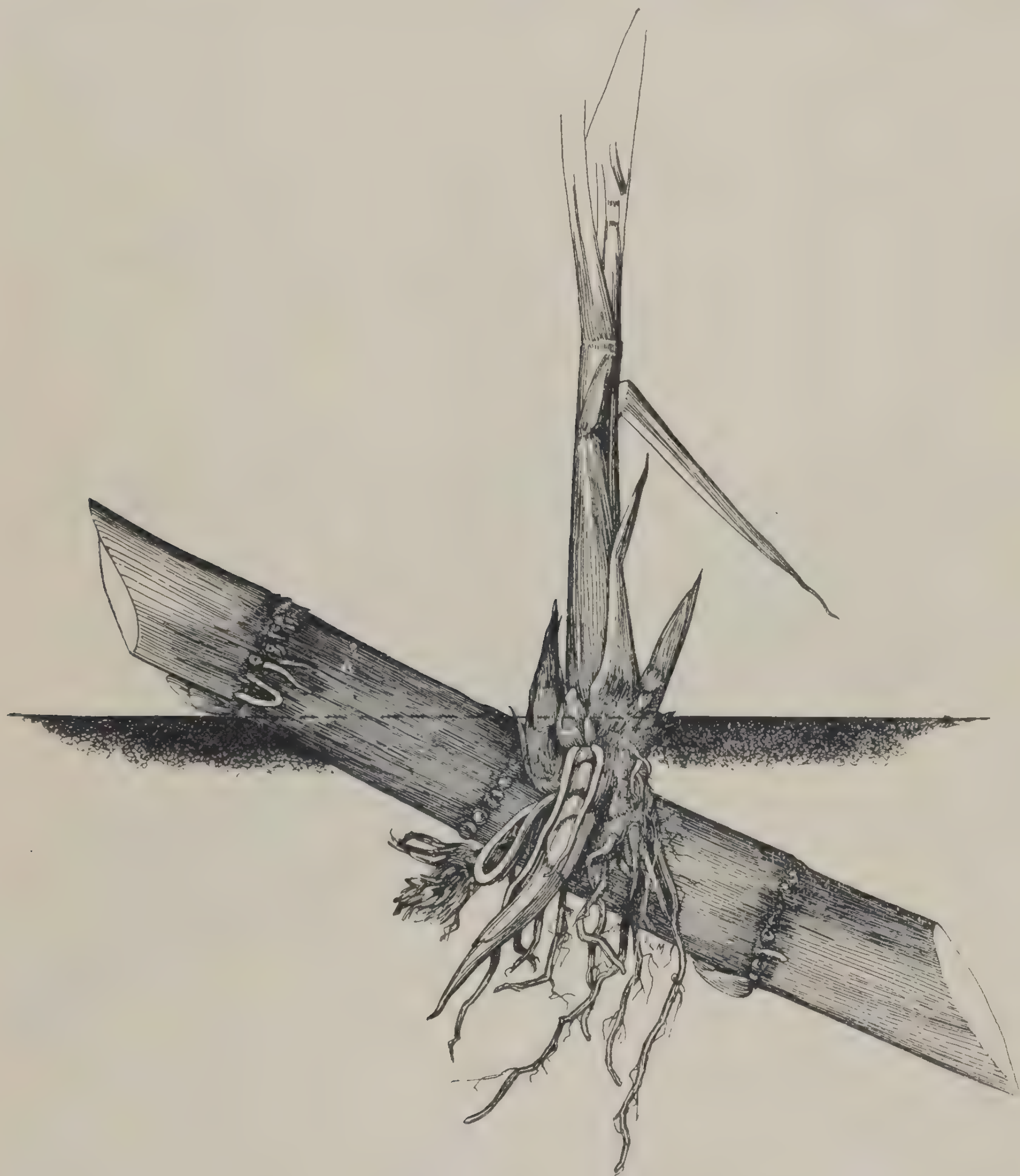

FIG. 5. This is a view of a cane stool six months after being planted. The development of various young stalks where the first stalk started may be noted.

be determined in a large measure by the amount of soluble plant-food material in the soil.

In Fig. 5 may be observed the development of a cane stool after a growth of six weeks. During this time the land was both cultivated and irrigated twice. The soil upon which this cane was grown consisted of a light clay loam the upper surface

of which had a tendency to dry out quite badly. In consequence of this condition the roots have penetrated downward to a constant supply of moisture.

Fig. 6 shows the development of a cane stool two months

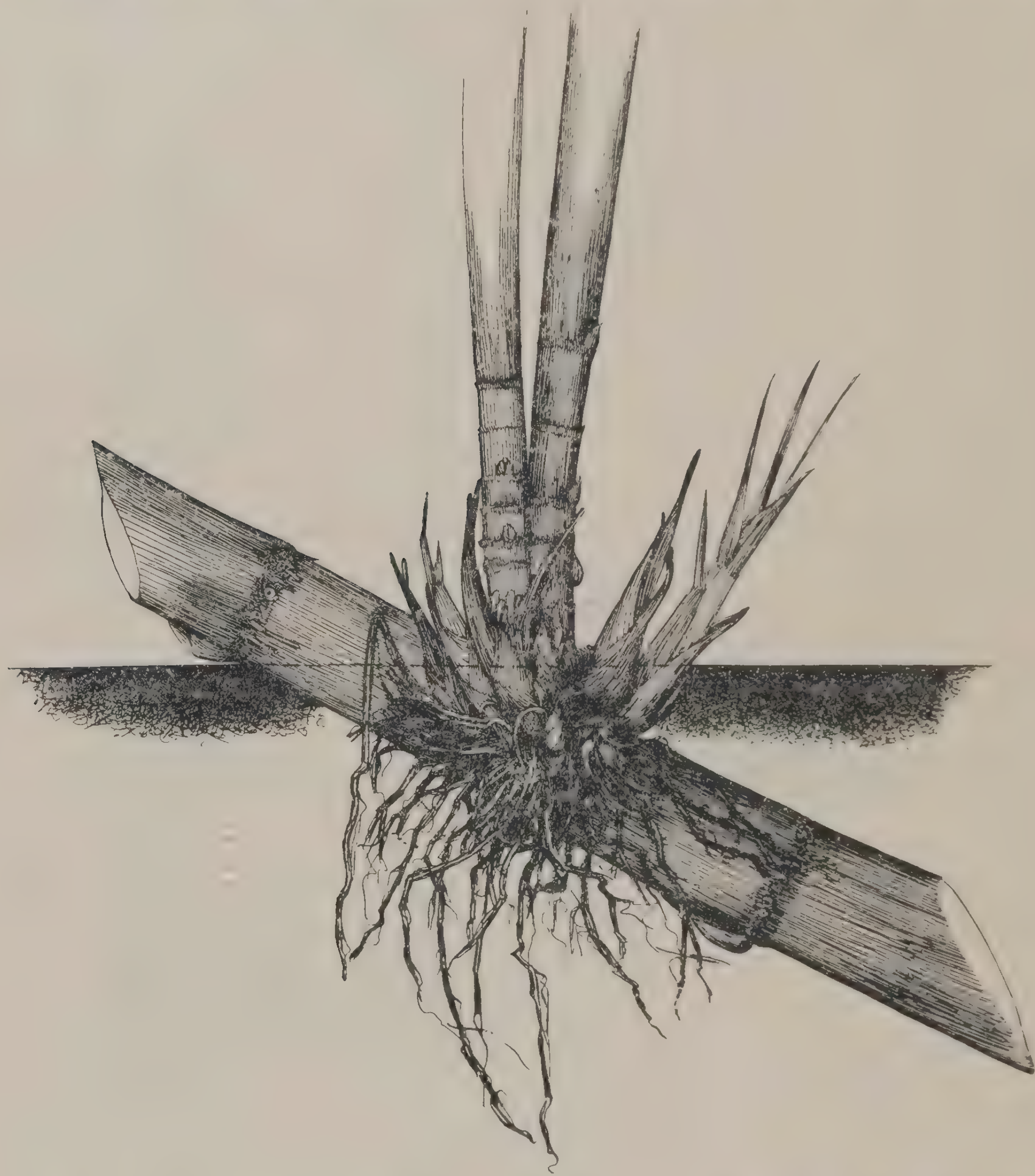

FIG. 6. View of a stool of cane after development of two months. The land upon which this cane was grown consisted of a fairly heavy clay which contained an abundance of moisture at all times. Thus the root system has spread out near the surface instead of penetrating to the lower depths as in the previous case.

after planting. In this case the land consisted of a heavy clay loam which was more or less damp continually. This condition caused the roots to spread out near the surface rather than penetrate downward as in the previous case.

*Method of planting the cane.*—The method followed in planting the cane is largely determined by the prevailing conditions which

include the nature and texture of the soil, the available moisture, the probability of drought while the cane is yet young, etc. It is always well to plant the points sufficiently deep in order that the young plants will be within reach of an abundance of moisture to keep them growing even during the dry season. Whether the cane is planted deep or shallow it is a good practice to place the points at an angle of from 30 to 40 degrees to the horizontal since this will enable the young stalks to reach the surface with less difficulty than would be experienced with those which happen to be directly underneath the point when laid flat. Some planters use the slant method, however, when the land is sufficiently retentive to prevent its losing moisture during the dry season, but on lands which dry out badly the flat method is used. It is here that the interesting study of the root system

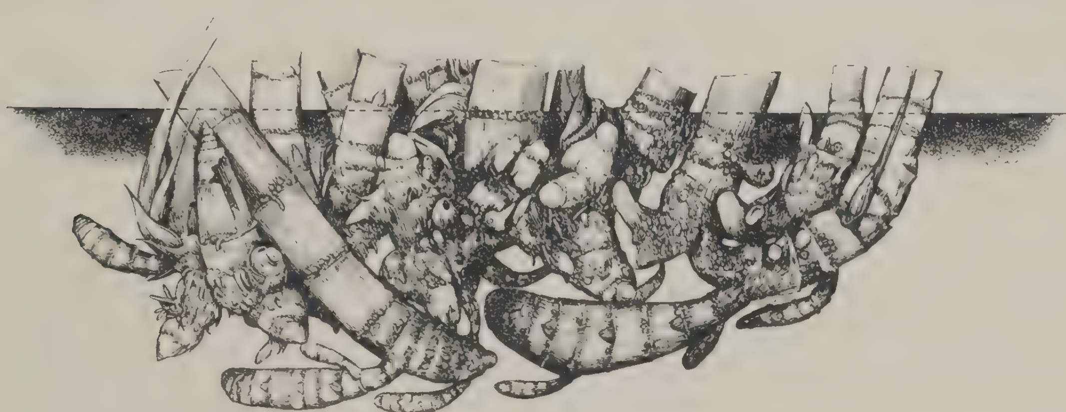

FIG. 7. Main root system of a stool of fourth ratoon sugar cane. A great number of rhizomes have been developed in this stool which indicates that favorable growing conditions prevailed.

is begun, for no sooner does the delicate bud become well started than evidence is noted of the development of an underground system that is peculiar to the sugar cane and various other plants.

*Root system of sugar cane.*—It is observed at the very early stage that a peculiar underground structure has begun to develop which upon examination is found to contain all the characteristics of rhizomes or underground stems with nodes and buds and possessing the property of tillering. This kind of root system, better shown in Fig. 7, serves a three-fold purpose: To secure plant-food material from the surrounding soil, to conserve a supply of plant-food material for the delicate plants when first started, and to extend the area by vegetative propagation.

The rhizomes contain in themselves a large supply of plant material which is essential in giving the young cane a start.

This is of particular importance and is one of nature's methods of supporting the delicate plant until its root system is capable of reaching forth and securing a supply of plant material from the surrounding soil. It serves a further purpose in those countries where the roots necessarily lie dormant for a period of time because of the cool weather, which is that of conserving a supply of plant-food material and awaiting the future demands of the plant.

Another thing of interest regarding the rhizomes of sugar cane is that they may be removed from the main root structure and transplanted the same as original points. This system of extending the area is known as vegetative propagation.

Since it is from this portion of the plant that the new stalks emerge, the number of stalks that will be produced with each stool of cane is entirely dependent upon the development of this portion of the plant.

Fig. 7 is a drawing of a stool representing the fourth ratoon. In this case the roots have been entirely cut away leaving the main underground system in its natural state. It will be observed that the rhizomes vary greatly in form, some being long and crooked while others are short and pear shaped. All contain numerous nodes set with perfectly formed buds although they are small and when properly developed may produce other rhizomes or stalks of cane. The rhizomes contain an astonishingly large number of nodes which in a large measure accounts for the number of stalks that are possible to the cane stool. This portion of the cane plant is in the nature of a perennial and the number of years it will survive is dependent upon the limitations of the soil and the cultural treatment given. That portion of the plant above the ground, known as a culm, is quite different since it is essentially an annual and can be made to survive for a longer period only under abnormal treatment such as the administering of heavy applications of water just previous to and during the maturing season, thus preventing the cane from reaching maturity in the normal season. With many varieties of cane, especially seedling varieties, the function of flowering, or "arrowing" as it is commonly called, marks the maturing season. This also marks the period when the maximum sucrose and minimum amount of glucose are being elaborated in the cane. After a time, usually from two to three months, important changes take place in the appearance and composition of the cane. It presents every aspect of being in a dying condition. The leaves turn yellow and then brown, the stalks dry up, the

moisture content diminishes, sucrose decreases, glucose and organic acids increase, and after a time there is a breaking down of the cellular tissues of the plant. All of these changes are in the above-ground portions of the plant while less radical changes take place in the underground portion. The roots proper die leaving the rhizomes or underground stems as the only means of reproducing the plant.

With the above knowledge of the root-system it is obvious that in order to produce successful ratoon crops special attention must be given the root system as soon as possible after harvesting the previous crop.

The application of a large supply of irrigation water to thoroughly saturate the soil will facilitate the future work. Fairly deep cultivating followed by hand hoeing may then be resorted to during which time much of the earth which was previously located near the main root system is thoroughly loosened up and partly removed. A liberal application of a fertilizer containing the necessary plant-food material for that particular soil should then be incorporated with the soil which is brought near the root system. This work serves a three-fold purpose: To loosen up and aerate the soil, to bring in near the root system a new soil which has not been deprived of its soluble plant-food material, and to remove the soil which was partly exhausted of plant-food material as well as laden with the toxins from the previous crop.

During the first cultivation little danger will result to the root system by close cultivation since the roots of the old plant if not already dead are doomed to perish within a very short time, but the subsequent handling of this work must be done with care since any injury to the rhizomes after they start to develop is likely to be detrimental to the future growth of the plant. Care should therefore be exercised not to disturb the young plants during the subsequent operations of cultivating the cane. The next step is to always maintain over the top of the ground a mulch of fine earth or cane leaves from the previous crop in order to conserve the moisture. A bountiful supply of soluble plant-food material as well as moisture and a loose, well aerated soil are essential to the proper development of the crop at this stage.

It must be constantly borne in mind that the primary thing in producing a large ratoon crop is to induce the proper development of the rhizomes which results in large stools of cane. The development of the individual stalks will be discussed later.

Fig. 8 is a representative view of a cane point planted flat in the row. This point was planted at a lower level than was done with the cane placed at an angle since it was desirable to have the root system of the new plant within reach of a bountiful supply of moisture and instead of the roots spreading out as in the previous view they penetrated downward in search of available moisture. It will be observed that this system of planting is practised mainly in loose dry soils which are likely to suffer from drought during a portion of the year.

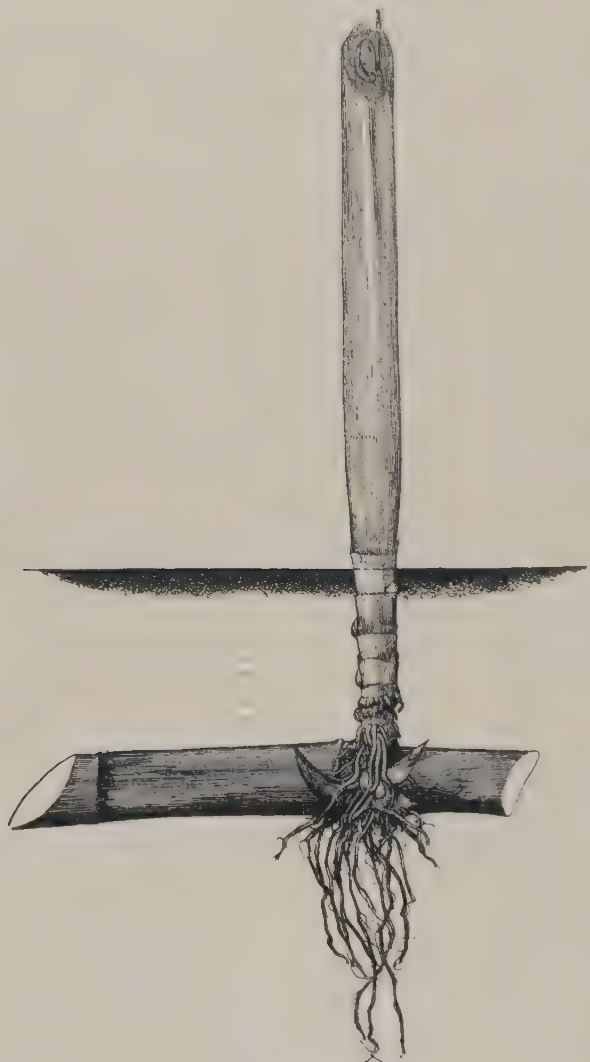

FIG. 8. View of a cane point laid flat in the row, showing the development of one month.

*Distance of spacing.*—In providing for ratoon crops, the work must start not after the ratoon crops have begun to develop but at the time of preparing the land and planting the plant cane. All work at this time must be done with a view to the proper care not alone of the one crop but of those crops which will follow in the various years to come. The next thing of importance is to properly space the rows as well as also the cane in the rows. If the spacing is too wide there is likely to be reduced yields by reason of the small number of stools, while if the spacing is too close the stools are likely to be crowded and small canes will result. In the spacing of the rows, it must be borne in mind that ample space must be left for the proper cultivation work. This is especially important when there is a heavy bed of cane leaves and trash on the surface from the previous crop. Under conditions in the Philippines, it has been found that a spacing of $1\frac{1}{2}$ meters is the most economical distance for the rows.

In planting the cane the number of points to the linear meter

will be largely determined by the condition of the points as well as the condition of the soil. In other words the percentage of germination of the points should determine this matter. In ratoon crops if two stools to the linear meter or three well developed stools to two meters result, these are considered good indications of a successful ratoon harvest.

*Depth of planting.*—The depth at which the rhizomes will be placed is largely determined by the depth of planting the original points. It is a good practice to locate the root system at a sufficient depth, especially in loose soils that are likely to dry out, in order to have them within reach of a bountiful supply of moisture at all times.

Bearing in mind that several of the essentials for making available the plant-food material are well aerated soils, plenty of heat and sunlight, and an abundance of the moisture, and that in the building up of plant tissues and the storing up of sugar these same factors play such an important part, it will be seen that the sugar planter himself is more often responsible, through his method of handling the crop, for the fact whether or not ratooning may be practised than is fertility of the soil alone.

## BOOK REVIEW.

Reviewed by CLEVE. W. HINES, *Sugar Technologist.*

### CHEMICAL CONTROL IN CANE-SUGAR FACTORIES.

A valuable book bearing the above title has recently been written by the well known sugar expert Dr. H. C. Princen Geerligs. This is the fourth book published by Dr. Geerligs in recent years on the various phases of the subject of sugar and sugar men the world over have learned to look forward with a great deal of interest to the publication of books and reports by this well known author. This new book is divided into seven parts as follows:

Part I. Analytical Methods on Cane, Bagasse, Mill Juices, Raw Juice, Clarified Juice, Sweet Waters, Press Cake, Syrup, Massecuites, Molasses, Sugars.

Part II. Determination of Quantities, Direct Weights, Calculated Weights.

Part III. Stock Taking Calculated Percentages.

Part IV. Various Calculations.

Part V. Factory and Laboratory Instructions.

Part VI. Tables.

Part VII. Models of Books Used in the Chemical Control of Sugar Factories.

The book may be obtained from Norman Roger, 2 St. Dunstan's Hill, London, England, Price, 10 shillings.

# CURRENT NOTES—SECOND QUARTER.

NOTES BY CLEVE. W. HINES, Sugar Technologist.

## THE SUGAR HARVEST OF THE PHILIPPINES.

The harvest of the present sugar crop of the Philippines has been rather discouraging on account of the unfavorable weather conditions which have been prevailing in the Island of Negros—the most important sugar district—during much of the present harvest period and which obtained during the same season of last year, thus causing the young cane to be badly damaged from the excess of water and preventing proper attention to the crop at a time when cultivation was of material importance. One encouraging fact in connection with the recent harvest, however, is the improvement of the grade of muscovado sugar manufactured. This is due largely to the gradual adoption of more modern methods advocated by this Bureau in the clarification of the juice and the crystallization of the sugar. There are also increasing quantities of centrifugal sugar manufactured in the modern factories here.

## EFFECT OF EXCESSIVE WATER ON YOUNG CANE.

During the past year the effect of water in excess on sugar cane representing different stages of growth in various classes of soils was carefully studied at the experiment stations of this Bureau. It was observed that extremely young cane suffered more from an excess of water than older cane. Likewise cane grown on light soils was damaged less than that grown on heavy clay soils. During the first month or six weeks while the roots were very small and delicate an excess of water caused a check in the growth of the cane, the ends of the more delicate roots often dying while the color of the leaves became yellow. In consequence of these adverse conditions the cane became stunted and required extremely favorable conditions to cause it to recover, if indeed it recovered at all.

When cane of two or three months' growth was subjected to the same conditions the root system, being well developed,

was not so dependent upon the extremely young and delicate roots and in consequence it had better chances of assuming normal growth in time after the excess of water had been withdrawn.

### NEW SUGAR CENTRAL PLANNED.

A new sugar factory has been planned for the Pampanga sugar district of Luzon. This factory will be strictly modern in every particular and will be built with an initial capacity which will eclipse that of any of the modern factories at present in operation. Because of the high sucrose content and purity coefficient of the sugar cane grown in that province, a factory there should experience a profitable run from the very beginning.

This district has been grown to sugar for more than a century and a one-crop system only has been employed which has caused the land to be somewhat depleted of its plant-food material. This accounts for the comparatively low tonnage obtained per unit area. While it is true that a high percentage of sucrose and purity coefficient are obtained from the cane grown there yet the sugar manufacturer profits more in proportion from these favorable factors than does the planter, under the present system of contracting for the cane in the Philippines.

### IRRIGATION FAVORABLY RECEIVED.

The modern system of growing cane by the aid of irrigation is now favorably received by the Filipino planters at the Mindoro Sugar Estate where it is now difficult to provide enough water to satisfy their desires notwithstanding the fact that the six-foot tunnel which passes through a hill to the Busanga River should supply an abundance of water for a much larger area than that now under cultivation. This is in marked contrast to the condition of affairs prevailing last year when some of these same planters not only refused to apply the irrigation water provided them but also objected to the company's irrigation force doing the work when they attempted to save the cane crop from the long drought. When such convincing proof as the above results from the observations of cane growth on irrigated and unirrigated plantations in the period of one year, it is anticipated that equally encouraging results will be obtained from the observations of the results of properly and improperly irrigated plantations during the next few years and thus a better understanding will be had if the most effective method of applying the water is employed and the proper quantity is used in order to obtain maximum results.

### INTRODUCTION OF NEW REFINING METHODS.

A representative of the English firm handling the Noriet patent or "vegetable-char" process for filtering and bleaching cane juices recently visited the Archipelago with a view to introducing into the Islands their process of making white sugar. It is understood that the patent rights for the Archipelago were purchased by a local firm and henceforth their process will be employed in preference to the bonechar which is said to be much more expensive and in addition at present very difficult to procure.

### PROPER AMOUNT OF WATER FOR SUGAR CANE.

Experiments conducted at the sugar experiment station of La Carlota, Occidental Negros, during the past three years on the irrigation of sugar cane have demonstrated conclusively that while a great deal of water is naturally required for the production of a crop which contains upward of 85 per cent of water and a large per cent of organic products derived either directly or indirectly from water, yet there is a fixed and definite amount that is required to give maximum results for each class of soil and for cane representing the various stages of growth. It was observed that an excess of water was always followed with bad results and that the application of a liberal amount of irrigation water at intervals of three weeks on lands composed of a light clay loam followed by thorough cultivation in which a fine mulch was left on the surface of the ground gave far greater results than were obtained by frequent and heavy applications of water. The theory that "irrigation would replace cultivation" was entirely disproved during these experiments.

### SUGAR AS A FOOD.

With refined sugar at the abnormally high figure of 17½ cents per kilo where it has been for the last several months it is considered by the ordinary consumer as a very expensive food. When it is realized, however, that each kilo of sugar upon oxidation give upward of 3,850 calories of heat or from four to five times as much as would be obtained if the same amount of money were invested in beef and pork and about three times as much as would be obtained from such concentrated articles as cheese, it becomes apparent that sugar is in reality a very cheap article of food as compared with other foods.

Another fact not generally realized in regard to sugar is its stimulating effect upon the human system. It has recently been

observed that soldiers when worn out by a long drive and constant exposure recover their strength more quickly by the use of a limited amount of sugar than by any other food or stimulant.

### POOR STAND OF CANE.

Recent dispatches from the Mayaguez and Arecibo sugar districts of Porto Rico state that extremely poor stands of cane were obtained from the recent planting and the Insular Agricultural Experiment Station staff was requested to investigate the case as it was feared that some new plant disease was the cause. Upon examination, however, it was found that the trouble resulted from using poor cane points and also from lack of attention to cultivation during the critical period of growth as well as a possible deficiency of needed plant-food material.

This same condition of affairs is brought to the writer's notice from different parts of the Islands almost every year, but in this country it is particularly common during the month of April and the forepart of May since at this time there is scarcely enough moisture in the top layer of the soil to give the points a start or at least to enable them to retain their vitality until the showers begin to appear. As a consequence of the cane remaining in this condition for a time, insects, particularly white ants, burrow into the points and the planter usually believes these insects are the cause of the point dying while as a matter of fact their presence is but a result of the point having died or at least partly dried up, thus providing plant tissue in which the pests may lodge.

### COLLEGE TO GIVE COURSE IN SEED PRODUCTION.

The future of the beet-sugar industry in the United States is directly dependent upon the supply of beet seed obtainable which in antebellum times came from several of the European countries, but on account of the difficulties experienced in securing the seed under present conditions the farmers have been facing grave difficulties and indeed in some cases lands have gone unplanted.

Recognizing the importance of training men in the production of beet seed with a view to making the farmers of the United States independent of the European source of supply, the Utah Agricultural College, after carrying on preliminary experiments, has established a short course for training young men in this particular phase of the subject.

The United States Department of Agriculture has likewise gone to considerable length in its research work on this subject and as a consequence of the efforts of the Agricultural Department as well as the experiment stations the realization of their aspirations of only two years ago is being felt and it is hoped that within a short time the United States will be entirely independent of the other countries in this respect.

If such encouraging results are obtained in an industry which ranks, not as third in importance as does the sugar industry here, but which is of much less importance comparatively, and yet where the latter industry is already carried on along modern lines, one can only imagine what results might be obtained by such a move to teach the farmers in this country where the industry in general is in an extremely backward condition, where the systems employed are the most antiquated to be found anywhere in the world today, and where a large part of the sugar manufactured commands a low price in the market because of its inferior quality.

There is no doubt but that very great results would accrue from the establishment of a sugar school where the students might take not only an extensive course of five or six years like that of the Audubon Sugar School of Louisiana, but also where the farmers themselves might attend a short course during the off season and be taught the various operations in sugar manufacture along modern lines.

Under present conditions all that is possible in this direction with the limited means available is the instructing of the proprietors at the various sugar mills and on the various cane lands who appeal for help, and the giving of illustrated lectures from time to time in which the different plantation problems are discussed and in the distribution to the planters of literature bearing on the various subjects.

Considering the small sums allotted to this work it is felt that wonderful results have been accomplished in this direction, but with an appropriation of a size to which the planters are justly entitled such startling results would surely be obtained that the industry would scarcely be recognized after a period of a few years.

### HIGH WAGE ON SUGAR PLANTATIONS.

In Hawaii, Porto Rico, and various other tropical sugar-producing countries the wage of the common laborers has constantly advanced until it has now reached upwards of $1. This

is quite a contrast to the wage paid to workmen here which usually ranges from 40 to 80 centavos Philippine currency ($0.20 to $0.40). The question is often asked how can those planters afford to pay such high wages in the production of an article in the other countries which brings the same market price as that of the Philippines when made into the same grade of finished product.

The explanation is simply that in those countries the industry is carried on along modern lines, the land is made to give maximum results at a minimum expense, wastes in the process of manufacture are minimized by the aid of modern methods and by the employment of skilled technical men, and the grade of the direct output is such as to command the highest market price.

When the industry here is carried on along similar lines the laborers will receive higher wages, which will mean better living, better home conditions, and better opportunities for their families. The producer of the cane will secure a better profit on his product which will mean more money for improvements, better handling of the land, and greater conservation of the plant-food elements in the soil, thus preserving them for future generations. It will also mean greater tax returns or a greater amount of money for public improvements and in reality this condition of affairs will spell prosperity in general to the sugar districts.

## DECREASE IN BEET PRODUCTION IN GERMANY.

There is perhaps no place in the world where more intensive methods are used in sugar production during normal times than in Germany. Many years ago it had been scientifically demonstrated that intensive farming and the application of large quantities of fertilizers gave phenomenal results in sugar-beet culture. During recent years, however, it has been next to impossible to obtain fertilizers in the desired quantities for even the reduced areas now cultivated to beets. As a consequence the yields have decreased in many cases as much as 50 per cent.

In order to successfully meet this emergency and provide more fertilizers for the land the planters have appealed to the factories for a larger percentage of the exhausted pulp which will first be used as a stock food and later returned to the soil as an almost complete fertilizer.

In this country at the majority of the mills which have not adopted modern methods may be seen great heaps of bagasse ashes and the fermenting juice skimmings and other sugar-

house refuse which have been cast aside as being of absolutely no value to the plantations.

When it is realized that the ashes represent a great portion of the plant-food material that was derived from the soil, except for the nitrogen and the small percentage of other plant-food material that was lost during the combustion in the furnaces, the planters should be anxious to apply this material to their soils and thus in a measure maintain the soil fertility for future generations even though it is thought by these farmers that the land is now too rich to produce the desired grade of sugar under the old system.

Experiments on some of the depleted soils on the demonstration stations of this Bureau have produced as much as three times the yields ordinarily obtained by the Filipino farmers, when no other fertilizer than discarded sugar-house refuse was used and this coupled with thorough methods of preparing and cultivating the land.

### INCREASED COST OF PRODUCING SUGAR.

According to a recent report from Louisiana furnished by the American cane-growers association the cost of producing "yellow clarified" or "plantation white" sugar has increased $\frac{1}{4}$ of one cent United States currency per pound over the cost in normal times. On account of the relatively low sucrose content in the juice from immature cane harvested in that subtropical state in addition to the low fiber content of the cane it is necessary to use a great deal of extra fuel which is a heavy expense during the high cost of the various classes of fuels.

As a contrast with the above condition the sugar factories here which employ modern crushing plants have not only an abundance of bagasse for heat and power but usually have a supply left over at the end of the campaign in cases where the factory has been running at full capacity.

### ENLARGEMENT OF PACIFIC COAST REFINERY.

Plans are under way for the enlargement of the massive Crockett Sugar Refinery. This factory, after the new additions, will be one of the largest refineries of the United States. It will derive practically its entire crude product from the sugar lands of Hawaii but in times when there is a scarcity of crude sugar some of the better grades of Philippine open-kettle and the centrifugal sugars find their way into this factory as well.

### HIGH FREIGHT RATES.

The abnormally high oversea freight rates have caused a very great difference between the market price of Philippine sugar in the United States and that paid to the planters here. In order to successfully combat this wide difference in price and cause a greater profit to accrue to the manufacturers a number of the modern factories have equipped themselves to turn out plantation white sugar in one continuous process. This is readily sold in the local markets. The price obtained for this sugar ranges from $1.50 to $2 per 100 pounds lower than that of standard refined sugar and this sugar is preferred by certain classes of people not alone because of its lower price as compared with the highly refined product but also because of the pleasant flavor which is characteristic of sugar-cane products.

El Progreso alcohol distillery where sap from the nipa palm (tuba) and low-grade molasses is used as a source of alcohol. Bulacan Province, Philippine Islands.

THE PHILIPPINE

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# RESUMÉ OF THE WORK OF THE VETERINARY DIVISION FOR THE YEAR 1916.

By Dr. STANTON YOUNGBERG, *Chief Veterinarian.*

The activities of the veterinary division during the year 1916 were in the main devoted to the control of contagious animal diseases, by far the most important of these being rinderpest. At the Veterinary Research Laboratory, even with a limited personnel, considerable valuable work has been accomplished during this period.

## PERSONNEL.

On December 31, 1915, the force consisted of 16 veterinarians (including 3 on leave), 10 American live-stock inspectors (including 2 without salary), 105 Filipino live-stock inspectors, 1 American clerk, 2 Filipino clerks, and 3 foremen (Americans).

On December 31, 1916, there were on the rolls 18 veterinarians, 24 American live-stock inspectors (including 5 without salary), 375 Filipino live-stock inspectors, 1 American clerk, 2 Filipino clerks, and 1 American foreman.

## ADMINISTRATION.

*Importation from foreign ports.*—During the year no dairy or breeding cattle arrived from foreign ports.

Small numbers of cattle for work purposes and slaughter were imported from Pnom Penh, Hongkong, Tsingtau, Saigon, and Formosa, as well as cattle of Indian breeds via Singapore.

*Interisland shipments.*—During 1916, there arrived at Manila from interisland ports 14,916 cattle and 1,589 carabaos. This shows an increase of nearly 10,000 in the number of cattle arriving over the previous year.

*Inspections for which fees were charged.*—During the year 113,193 animals of all kinds were inspected on arrival at the city of Manila, for which fees amounting to $7,431.20 were collected. Of these animals 86,257 were swine. Fees amounting to $2.20 were collected at Zamboanga on animals arriving from foreign ports.

*Post-mortem inspections at the Manila slaughterhouse.*—There

were 109,025 animals of all kinds inspected at the Manila slaughterhouse during the year, 1,760 being condemned, and 107,265 passed for food.

### ANIMAL-DISEASE CONTROL.

*Rinderpest.*—A very severe outbreak of this disease accompanied by heavy losses occurred during the year. The number of cases and deaths recorded in this office for the year 1916 is 23,808 and 18,251 respectively; that is, 20,177 cases and 15,946 deaths more than the total reported for the year 1915, and 5,658 cases and 6,731 deaths more than were reported for the entire previous four and one-half years. It is the opinion of the writer that the mortality figures for 1916 are only about 50 per cent complete. As the division personnel has not been large enough to cover more than territory known to be infected, it has been necessary to depend almost entirely upon the local officials for the primary reports of infection. In several instances it has been afterwards ascertained that the disease had been going on for some time and had been responsible for a considerable mortality before being reported to this office by local officials. It has been impossible to obtain reliable and convincing information as to whether the officials in question reported the existence of rinderpest in their respective jurisdictions as soon as they knew of its presence. Also the governor of one of the near-by provinces in a recent conversation with the writer stated that he only recently became aware that one municipality in his province had lost about a thousand animals during the past year, though less than one-tenth that number had been officially reported. He became aware of this fact through the large number of applications for loans from the National Bank that arrived from this municipality. For the most part, the reasons assigned for making these requests were that it was desired to replace their work animals that had died during the year.

The large increase in rinderpest infection during the year 1916 can be accounted for in great measure by the fact that the Islands had not suffered from a very severe epizoötic for about ten years, i. e., since the outbreak of 1905–06. During the intervening years of comparatively mild infection thousands of young animals, more or less highly susceptible, had been born; by the end of ten years these animals would naturally constitute a good percentage of the total number and owing to their greater susceptibility would contract the disease more readily than the older, more highly immune animals.

As the infection occurred in the midst of the electoral campaign, it was not an easy matter to secure the establishment of strict quarantines. As the majority of farmers are opposed to quarantines, the attitude of the elective officials can be readily understood. The animals in an infected area must be kept tied up and fed and watered by the owner or caretaker, and as it has been the custom for generations to let the carabaos and cattle pick their own living, the quarantines naturally interfere with an established custom and therefore cause opposition.

This office realized early in the year that a severe epizoötic was developing with considerable rapidity, and also that owing to a somewhat limited appropriation the division force would be entirely inadequate to cope with the situation. These facts together with that of the difficulty of securing the enforcement of effective quarantines were laid before the Secretary of Public Instruction, then Acting Governor-General. The Bureau was advised to do the best it could under the circumstances, to appoint additional personnel (i. e., live-stock inspectors) as needed from time to time, and to apply to the Emergency Board for additional funds.

In July, immediately after the elections, His Excellency the Governor-General, called a conference of the governors of the infected provinces to discuss means for increasing the effectiveness of the campaign against the epizoötic. As a result of this conference two amendments were made to Bureau Rules and Regulations. The regulations formerly provided that if a case of rinderpest occurred near the boundary line of an adjoining barrio, the portion of this barrio within a radius of 1 kilometer from the infected barrio should be included in the quarantined zone. The amendment made it possible to reduce this radius to 500 meters. Ordinarily work passes were not issued until fifteen days had elapsed from the discovery of the first case. This was amended permitting the issuance of such work passes before the expiration of the fifteen days after the first case on the condition that the animals be muzzled while at work. It has been found that when it becomes necessary to issue large numbers of passes in infected areas, no marked diminution of the rinderpest infection can be expected until the animals can again be restrained.

At this time also, owing to the approaching exhaustion of the funds assigned to this division, the Honorable the Secretary of Public Instruction directed that the matter of obtaining additional funds for the employment of live-stock inspectors be taken up with the Emergency Board. After a careful study of the

situation and of the funds of the Bureau of Agriculture, the Board made an allowance of $55,000 for salaries and wages of temporary men employed by the Bureau of Agriculture and for corral guards and special police employed by the provinces not financially able to pay them, and $12,500 for the payment of traveling expenses of Bureau of Agriculture employees and also those of municipal police when assigned by the governor of a province outside of their own municipality, when said province was not able to pay these expenses. This latter amount proved to be insufficient, however, as at the end of the year the Bureau was facing a deficit of $10,000 in the funds covering traveling expenses of personnel. An allowance of $21,410 was also made for the purchase of the necessary equipment and animals for the installation of a laboratory for the production of antirinderpest serum, as there was a constantly growing demand for this product owing to the heavy losses being caused by the rinderpest. The serum produced has been sold at an average price of $1 per dose, it having been estimated that this amount is about enough to cover actual cost of production, freight and express charges, and the traveling expenses of the field men for the purpose of injecting the serum. The establishment of the laboratory progressed so nicely that serum was ready for sale by the month of September. From September to December 914 liters were prepared; of these, 700 liters had been sent to the provinces, 58 had been used at the laboratory and 135 were on hand at the end of the year.

During the year it was definitely proved that swine contact had spread rinderpest, a fact which greatly complicates the problem of eradicating this disease.

During previous years the idea had been allowed to become disseminated that the eradication of rinderpest was possible in the not distant future. This was indeed unfortunate and to a great extent undoubtedly accounts for the popular impatience with the seemingly slowly acquired results in the eradication of this disease.

Carabaos and cattle, which are the animals most used as beasts of burden in this country, are unfortunately the animals most susceptible to rinderpest. They are also allowed to run at large and mingle freely, herd with herd, on unfenced land. Another complicating factor is the fact that swine, goats, and sheep also become infected with this disease, and these animals are almost constantly running at large. Thus it is seen that the problem of eradicating rinderpest is a very difficult and serious one, and

its ultimate eradication from the entire Archipelago is still very remote.

The distribution of the cases and deaths reported is shown by three-month periods in the following table:

*Rinderpest cases and deaths during 1916.*

| | New cases. | Deaths. |
|---|---|---|
| First quarter | 1,997 | 1,435 |
| Second quarter | 7,580 | 5,712 |
| Third quarter | 9,857 | 7,638 |
| Fourth quarter | 4,374 | 3,466 |
| Total | 23,808 | 18,251 |

The Bureau records for 1916 show that during the year 319 new outbreaks occurred, counting each town declared infected or reinfected during the year as a separate outbreak. This number may be compared with 187 in 1915, 139 in 1914, 97 in 1913, 162 in 1912, 257 in 1911, and 282 in 1910.

The year opened with 8 provinces and 20 municipalities infected and ended with 18 infected provinces and 87 infected municipalities. The total number of provinces infected during the year was 23, or more than during 1915.

*Immunization.*—On January 17, 1916, the Philippine Legislature enacted Act No. 2548 providing for the "immunization of cattle and carabaos to prevent the spread of rinderpest." A very wise feature of this act is the clause that appropriates the sum of $25,000 for an "Immunized Cattle Insurance Fund" to assist the provinces in covering deficits that may occur at any of the immunizing stations created in accordance with the Act.

The work of immunization during the year was extended as far as consistent with the money available for that purpose. Outside of the regular Bureau immunizing stations at Manila (Pandacan Quarantine Station), Iloilo, and San Fernando, Pampanga, only one small herd of animals at Paniqui, Tarlac, was immunized. The stations at Manila and Iloilo are primarily for imported animals and the importers pay the actual cost operations and assume the risks of any losses that may occur. At Pandacan, however, 11 head of native animals were immunized at the request of the owner.

It was possible to operate only one provincial station during the year owing to the fact that Act No. 2651 provided a sum of only $12,500 for work of immunizing. This station was located at San Fernando, Pampanga, and had been established

there since October 24, 1915. It was temporarily closed in June owing to the fact that the people had to use their animals during rice planting. It was reopened at the beginning of September but was again closed in the latter part of November because the people were all busily engaged with the sugar-cane harvest. A substation was, however, constructed at Santa Rita as animals for immunization were available in that section; this substation is operated by the personnel of the main station at San Fernando of which it is carried on the records as a part. The total number of carabaos and cattle immunized in Pampanga during the year was 2,075, with a total mortality from all causes inside the station of 155, or 7.4 per cent. Seventeen animals died from such causes as colic, tetanus, abortion, and paralysis. Unfortunately, from a financial standpoint, these animals have to be paid for when the deaths occur inside the station. The people realize only the fact that their animals were injected with blood and an ambercolored liquid and some time afterwards they died. It is impossible to explain to their satisfaction that the deaths were not primarily due to the injection and that therefore the animal should not be paid for, or that if any reimbursement is made that it should be a very nominal amount.

Another difficult and complicating factor is that many people do not bring in their animals for immunization until rinderpest appears in the immediate vicinity. As a result it happens that animals already in the period of incubation arrive at the station and are injected, and thus one, two, or three days afterward show the symptoms of the disease. The veterinarian in charge of the station cannot be blamed for this, as there is no method yet known by which one can tell whether or not an animal is already infected with rinderpest and in the period of incubation. Experience seems to indicate that when an already infected animal is injected with virulent blood the severity of the attack is increased. A remedy that might be suggested would be that of obliging all animals from infected districts to undergo a week's observation outside of the station before being admitted. It is hardly likely, however, that the people would willingly acquiesce in this, as the length of time already required for the immunization is three weeks; this added observation period would therefore result in keeping them away from home for a month. The period of three weeks necessary for the immunization is a fairly heavy burden on many people, who would gladly pay more money if the time could be reduced. At the present time it therefore appears that all that can be done

with regard to these complicating factors is to realize that they may occur at any moment and meet them when they do arise.

At Iloilo, 1,967 head of Indo-Chinese carabaos and cattle were immunized with a loss of 203, or 10.3 per cent. Several discouraging factors had to be contended with at this station during the year. In the first place every shipment arrived already infected with rinderpest, which of course complicated matters at the very start. In one shipment a great number of the animals showed clear evidence of having recently been through an attack of foot-and-mouth disease, which is a very debilitating malady; several of the carabaos were hardly able to walk owing to the sores and infection in the feet. Also two of the largest shipments arrived in very bad condition owing to rough and delayed voyages; one lot had used up their feed three days before arrival at port. At the insistence of the importers the animals were injected within a few days after arrival. This was disastrous, as the animals were in very poor condition and could not withstand the reaction. Heretofore the importers have always insisted on having the immunization begun immediately after the arrival of the shipments, as they have had a tendency to lay too much stress on the cost of feed per day. Then when any bad luck happens there is always an attempt to lay the blame upon the Bureau of Agriculture. In order to avoid this as much as possible in the future it has been decided to hold the animals until such time as the Bureau veterinarian is of the opinion that they are in condition to receive the injections. The few days extra feeding will cost the importers less than the loss of several carabaos.

At the Pandacan Quarantine Station 313 cattle and carabaos were immunized with a loss of 28, or 8.9 per cent. In reality, however, 27 of these deaths should not be counted against the immunization; they were among a lot of Formosa calves that had been taken away from their mothers too young, could not digest and assimilate the feed they were given, and hence were in very bad condition. Most of them would have died from starvation eventually, as several of their mates did after being released and turned out on pasture by the owner.

In the month of November permission was granted to establish and operate a private immunizing station at Zamboanga for imported cattle of Indian breeds. During November and December 99 head of young Indian (Nellore) cattle were immunized. They were each injected with 10 cubic centimeters of virulent blood and no serum; 85 head had a good thermic

reaction, 12 of them also showing good clinical symptoms. Not a single death resulted. This proves the remarkable resistance of the Nellore cattle to rinderpest.

This office has recommended and still recommends the immunization of carabaos and cattle against rinderpest, which may in some cases be both feasible and advisable to extend to swine. This work must be regarded as a very important factor in keeping the disease under control, and one which may eventually be of prime importance in the eradication of the disease. The public must not, however, be led to believe that this a wonderful panacea which will bring about the complete eradication of the disease in a very short time or without the necessity of applying any other precautionary measures.

It is a known fact that some individual animals may suffer with rinderpest in such mild and obscure forms that it is exceedingly difficult for even trained men to establish a positive diagnosis. There is no doubt but that this is one of the main contributing factors to the almost constant presence of rinderpest in municipalities situated along the heavily traveled highways. If the animals used for hauling supplies and products along the main highways were immunized, this office is of the opinion that the continued spread of rinderpest would be greatly diminished and its control rendered correspondingly easier.

There are several difficulties that still have to be surmounted in the work of immunization. It is recognized that all animals do not have the same powers of resistance; in some cases a small amount of virus inoculated into an animal has no effect, while in another animal of the same age and weight the same amount of virus causes well marked symptoms of the disease and possible death. At the present time there is no test by which one can tell if an animal is susceptible, or if its resisting powers are below normal, nor is there any accurate and perfect way by which one can standardize the activity of the virus. R. E. Montgomery, Veterinary Pathologist for the Government of British East Africa, speaks of encountering the same difficulty. In his report for the year 1914 he makes the following statements: "The second problem to be solved is to obtain a virus constant in its virulence. Operating at the laboratory we believe that this is commonly of one strength, but I am of the opinion that variations have occurred in the course of our experiments, and this has at times somewhat interfered with the deduction we expected to draw from certain experimental observations."

Dr. Montgomery in the same report makes some other very appropriate remarks, as follows: "There is one other aspect of

our work to which I would direct attention. The diseases of East Africa, although in certain ways similar to those obtaining in other countries, are in many cases totally different when the question of prevention by inoculation is considered. Immunity and resistance on the one hand, and hypersensibility on the other are factors which naturally modify the diseases here and it is necessary therefore that we *decline to accept as satisfactory* the methods or lines of treatment advocated by other workers merely because they have been found applicable in other parts of the world."

The statements made above apply with equal force to animal-disease conditions in these Islands.

During the past three years 22,940 carabaos and cattle have been immunized against rinderpest by the Bureau of Agriculture. Of this number, 8,528 were imported animals from French Indo-China and Hongkong. The 14,412 native animals immunized are located in the provinces of Ilocos Norte, Pampanga, Nueva Ecija, Albay, and Tarlac. Up to the present time only 77 of these animals have been reported as afterwards having contracted rinderpest and died. This is less than four-tenths of one per cent. Due to a variety of causes there are some animals that do not become permanently immune, but as can be seen they constitute but a very small percentage. All the animals that this Bureau has immunized have been or are in rinderpest-infected districts, and have not been subjected to any quarantine regulations and have had ample opportunity to contract the disease.

Modifications have been and are being made in the dosage of virus and serum. The object is to turn out as high a percentage of reactors as possible and still avoid an excessive mortality during the process. In this connection, the writer again wishes to call attention to the difficulties previously enumerated.

These problems cannot be solved in a few weeks, but there is good reason to believe that satisfactory progress is being made.

The Philippine Legislature has been asked for an appropriation of $125,000 for the immunization of cattle and carabaos. It is understood that this amount has been approved by both the House and Senate and now awaits the signature of His Excellency the Governor-General. This will enable the Bureau to greatly increase its activities in this line of work.

*Recommendations.*—Experience has demonstrated that when rinderpest has already spread universally in a country destitute of fenced inclosures, in which herd mingles with herd in the most perfect freedom, its eradication by the ordinary quarantine

and sanitary measures is impossible. This is especially true now that is has been proved that swine play a large role in the dissemination of the disease. As long as these conditions prevail, it is feasible to adopt those measures that help lower the virulence and mortality of the disease. These results are best obtained by the use of serum, either alone for the production of a temporary immunity or combined with virulent blood for the production of a more lasting immunity.

In other words, the fact that the disease is enzoötic in these Islands, must be faced, and that therefore its complete eradication is still very remote. This being the case the people cannot continue to depend on the Government to furnish all the means where with to save their animals, and instead will have to learn to set aside some of their own funds for the protection of their live stock. A parallel can be drawn between rinderpest and hog cholera, especially as far as regards method of control. In the United States the farmers engage their veterinarians to apply anti-hog-cholera serum immediately upon the appearance of hog cholera in the vicinity, and by this means they are succeeding in keeping their losses down to the minimum. A great many of the States now require hogs to have been injected with serum before their importation is permitted. The regulations of the State of Kentucky are very good in this respect; they require a health certificate stating that the hogs have been immunized against cholera by the simultaneous method at least 21 days before shipment, of the serum-alone method within five days of shipment. The same thing could to advantage be required in this country with respect to carabaos and cattle in the interprovincial trade.

At the present time owing to the increased price of cattle, due to the great decrease of importation, some difficulty is encountered in obtaining a large and regular supply of animals that are suitable for the production of serum. In this connection the writer is of the opinion that one of the best ways to popularize and generalize the use of serum is to encourage private individuals to go into the serum-production business. Even to-day the Bureau serum plant cannot supply the demand, and as the use of serum becomes more generalized it would be increasingly more difficult to promptly fill all orders. When a stock owner orders serum he wants it immediately, as delays may cause the loss of valuable animals. The establishment of private serum laboratories will also be of advantage in another direction, in that their advertising will be of great assistance in stimulating the interest of the people in the control of rinderpest. Private

serum plants will of course have to be kept under Government supervision in order to insure the production of potent sera.

*Anthrax.*—Cases of this disease have occurred in the lowlands of Agusan Province. It is also known to be enzoötic along the shores of Laguna de Bay, where it takes it annual toll of victims, though these are not numerous enough to constitute a very serious problem. However, if in the future sufficient funds should be available for the extension of the work of the Veterinary Research Laboratory, the preparation of anthrax vaccine should be seriously considered.

*Hemorrhagic septicemia.*—During the past year this disease has been reported from the Provinces of Zamboanga (towns of Dapitan and Dipulog), Bohol, Occidental Negros, Pangasinan, and the Mountain Province; in the municipality of Ubay, Bohol, the losses were very heavy. In fact, this disease has been found to be more wide spread in these Islands than was previously thought to be the case. It can ordinarily be looked for immediately after the first rains of the rainy season. On account of its fulminating character, medicinal treatment is impossible and useless. Prevention consists in the removal of the well animals from the infected pastures and keeping them tied up until the later, heavier rains have commenced.

*Surra.*—During the past year surra has been on the increase and has caused heavier losses than for some years past, especially in Pangasinan and along the east coast of Tayabas. It is without doubt continually present in every province of the Archipelago. Up to the present time no preventive or curative has been discovered; this fact combined with the reduced personnel of the division has rendered impracticable the prosecution of any special campaign against this disease.

*Contagious pleuro-pneumonia.*—The only cases found in the Philippines during the year were among the cattle imported from Australia into Sisiman, Bataan, for slaughter. The quarantine notice issued some time ago by the Honorable the Secretary of Public Instruction, placing the barrio of Sisiman in quarantine to prevent the possibility of this infection spreading to animals in other parts of the Islands, is still in effect.

*Foot-and-mouth disease.*—No cases of this disease have come to the knowledge of the division except those at Pandacan and Iloilo among animals imported from French Indo-China. One of the shipments of carabaos arriving at Iloilo showed patent signs of having recently been through the disease.

*Glanders.*—Glanders is especially prevalent among the horses in the city of Manila; every month horses are ordered condemned

and destroyed. This disease is very pernicious owing to the fact that it is readily communicable to man. For the interests of public health a vigorously prosecuted campaign for its eradication from the city should be undertaken. This of course demands adequate personnel. Another factor that must be taken into consideration before beginning a campaign of eradication is the fact that no cure is known, the only remedy being the destruction of all positive cases. At times animal owners make severe protests against the destruction of any of their horses.

*Hog cholera.*—This disease is prevalent throughout the entire Archipelago and undoubtedly causes very heavy losses each year. It has been impossible to obtain any reliable statistics in regard to the number of cases and deaths. The custom of allowing the hogs to run at large and forage for themselves is the very thing necessary to keep the disease continuously alive.

### LIVE-STOCK IMPORTATION.

Unfortunately the Philippine Islands do not raise enough cattle for home consumption, thus necessitating the importation of beef and cattle to supply the demand. The great majority of the animals imported during the past year were cattle for slaughter.

No beef cattle arrived from Australia and practically no beef was imported from there during the year. During 1916, there arrived at Manila 3,056 cattle from Pnom Penh, 2,226 from Hongkong, 473 from Tsingtau, 267 from Saigon and 174 from Formosa. This constitutes a decrease of over ten thousand head as compared with the importations during 1915. This very marked decrease was entirely due to the excessive freight rates prevailing and the difficulty in chartering steamers. General Order No. 48 was issued on February 29, 1916, prescribing the conditions under which cattle and carabaos may be imported from Formosa for slaughter or for immunization. On October 26, 1916, General Order No. 50 was promulgated providing for the importation of cattle of Indian breeds through the port of Zamboanga for breeding purposes.

### ILOILO QUARANTINE STATION.

This station was used, as already discussed under "Simultaneous inoculation," for the immunization of cattle and carabaos arriving from French Indo-China. A slaughterhouse was also maintained where 123 Indo-Chinese cattle were slaughtered for the local market. During the year 133 cattle and 2,032 carabaos arrived from Pnom Penh, French Indo-China.

SISIMAN SLAUGHTERHOUSE.

No animals were received at this station during the year. One hundred and ten cattle remaining from the previous year were slaughtered, all which were passed as food. Two hundred and twenty-five cattle parts were condemned as unfit for food.

VETERINARY RESEARCH LABORATORY.

In January the pathologist, Dr. W. H. Boynton, visited Naga, Ambos Camarines, to investigate a mysterious condition that was causing the death of several cattle. It was found that the herd was heavily infested with intestinal parasites. Dr. Wharton, of the Medical College, University of the Philippines, identified the parasites and found four different species in the ox and two in the goat. These animals were pastured on low land and it was advised to move them to higher and drier pastures; this was done and later reports show a marked improvement in the herd.

An intramuscular parasite, new to the Philippines, was located in a carabao at San Fernando, Pampanga. This parasite was sent to Washington for identification and found to be a Sarcosporidian, *Sarcocystes blachardi.* No further cases have been observed and it is not thought that this parasite does a great deal of damage.

A small amount of antiswine plague bacterins was prepared during the year for people desiring them.

Work was continued on the cultivation of the virus of rinderpest *in vitro.* Experiments were also made in the cultivation of the virus in celloidin sacks placed in the peritoneal cavity of pigs without any results as yet toward increasing our knowledge in regard to the organism. The cultivation of the surra organism in celloidin sacks placed in the peritoneal cavity of dogs is being experimented upon.

Work was performed on the preparation of a vaccine for rinderpest using dried blood and tissue but without any encouraging results.

Experiments on the medicinal treatment of rinderpest have been carried out with uniformly negative results.

Experiments are under way to devise a method of attenuating the virus of rinderpest so that it might be used as an immunizing agent. Work is also being done on the concentration of antirinderpest serum by precipitating the globulins.

A new pneumonia in swine has been discovered the causative agent of which is a bacillus. It is rapidly fatal to rabbits and

guinea pigs. Experiments in the production of a vaccine against the disease are being conducted.

The causative agent of coconut budrot as well as the role which the coconut beetle plays in its transmission is under investigation. Some work is also being done on the causative agent of banana rot.

The most important work of the year was that on rinderpest in swine, which was brought to a successful conclusion. The following facts were demonstrated: (1) That pigs can contract rinderpest when exposed to cattle sick with rinderpest; (2) that pigs can contract rinderpest from pigs sick with rinderpest; (3) that pigs can contract rinderpest, by means of caretakers, from pigs sick with rinderpest; (4) that pigs can contract rinderpest when inoculated with blood taken from pigs sick with rinderpest; (5) that pigs can contract rinderpest when inoculated with blood taken from cattle sick with rinderpest; (6) that pigs can contract rinderpest when inoculated with a mixture of blood taken from cattle and pigs sick with rinderpest; (7) that pigs can contract rinderpest when drenched with blood taken from a carabao sick with rinderpest; (8) that cattle can contract rinderpest when exposed to pigs sick with rinderpest; (9) that cattle can contract rinderpest when inoculated with blood taken from pigs sick with rinderpest; (10) that cattle can contract rinderpest when inoculated with a mixture of blood from pigs and cattle sick with rinderpest; (11) that cattle can contract rinderpest when drenched with urine from pigs sick with rinderpest; (12) that carabaos can contract rinderpest when exposed to pigs sick with rinderpest; (13) that carabaos can contract rinderpest when inoculated with blood from pigs sick with rinderpest; (14) that pigs can contract rinderpest when inoculated with blood from carabaos sick with rinderpest; (15) that pigs can contract rinderpest, by means of the caretakers, from cattle sick with rinderpest; (16) that pigs remain immune to rinderpest after recovering from that disease for at least 665 days; (17) that pigs which have recovered from hog cholera may contract rinderpest and die therefrom; (18) that pigs which have been hyperimmunized to hog cholera can contract rinderpest; (19) that carabaos, cattle, and pigs vary but slightly in their susceptibility to rinderpest.

This goes to prove the great complicating factor of swine in the solution of the perplexing rinderpest problem.

Dr. Boynton's article on rinderpest in swine has been published in this REVIEW, and will shortly also appear in the Journal of Science, Manila, P. I.

# RUBBER CULTURE IN THE PHILIPPINES.

By P. J. WESTER, *Horticulturist, Department of Mindanao and Sulu.*

Rubber is the coagulated latex or milk obtained from various plants. Columbus seems to have been the first European to whom this substance was known, having become acquainted with it during his second voyage to America. While it was found useful in various ways previous to that time the industrial employment of rubber on a large scale dates back to 1874 when the art of vulcanization was discovered. Since then, with the advance of mechanical and electrical engineering, chemistry and other sciences, the uses of rubber have multiplied enormously, until now rubber is an important industrial necessity. Crude rubber is one of the staple articles of export from the Tropics and production and demand are increasing at a rapid rate.

Among the large number of trees, shrubs and vines that yield rubber the following species are the most important: Para rubber, *Hevea brasiliensis;* Ceara rubber, *Manihot glaziovii;* Mexican rubber, *Castilloa elastica;* Indian rubber, *Ficus elastica;* and the African rubber, *Funtumia elastica.* Attempts have been made to domesticate these species for plantation purposes. There are still a few plantations set out to Ceara, Mexican, and Indian rubber, but the Para has been found so superior to all the others that most of the plantations throughout the world are set out to this species. As a matter of fact botanists now recognize several species of Hevea that yield rubber, very closely related to the true Para rubber tree. The following discussion refers to the culture of this species.[1]

Not long after the industrialization of rubber in a large way the demand therefor began to outstrip the supply; in fact the

[1] Several years ago *Castilloa* was introduced into the region of Davao Gulf, Mindanao, where the trees have made excellent growth, and where this tree is now becoming rapidly naturalized through the agency of bats and birds, which eat the fruit. Already considerable quantities of rubber (for the Philippines) are produced from this source in Davao. Many people who are familiar with local conditions are quite optimistic as to the production here of rubber from the *Castilloa,* which is considered especially adapted to collection by the uneducated inhabitants.

price rose until, accompanied by the great demand, it became evident that there was a future for cultivated rubber.

In planting rubber the English easily lead all other nations in Ceylon and the Federated Malay States; the Dutch come second in Java and Sumatra. In other tropical countries rubber growing is still of little or no importance. The situation in the Philippines will presently be reviewed.

While some rubber was planted previous to 1900 practically all the large rubber estates have had their inception since that time.

The status of the world's production of rubber and the development of the plantation rubber industry is best illustrated in the following tables, adapted from a recent issue of the Tropical Agriculturist (Ceylon).

TABLE I.—*The world's production and area planted to rubber.*

| Year. | Area in rubber plantations. | Production. | | | |
|---|---|---|---|---|---|
| | | Plantation rubber. | Brazil. | Other countries. | Total. |
| | *Hectares.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| 1905 | 30,000 | 145 | | | |
| 1906 | 72,000 | 510 | | | |
| 1907 | 160,000 | 1,000 | 38,000 | 30,000 | 69,000 |
| 1908 | 218,000 | 1,800 | 39,000 | 24,600 | 65,400 |
| 1909 | 255,000 | 3,600 | 42,000 | 24,000 | 69,600 |
| 1910 | 314,000 | 8,200 | 40,800 | 21,500 | 70,500 |
| 1911 | 400,000 | 14,400 | 37,000 | 23,000 | 74,400 |
| 1912 | 450,000 | 28,500 | 42,400 | 28,000 | 98,900 |
| 1913 | 490,000 | 47,600 | 39,400 | 21,500 | 108,500 |
| 1914 | 531,000 | 71,400 | 37,000 | 12,000 | 120,400 |
| 1915 | 551,000 | [a] 107,900 | [a] 37,000 | [a] 15,000 | [a] 179,900 |
| 1916 | [a] 591,000 | [a] 145,000 | [a] 37,000 | [a] 15,000 | [a] 197,000 |

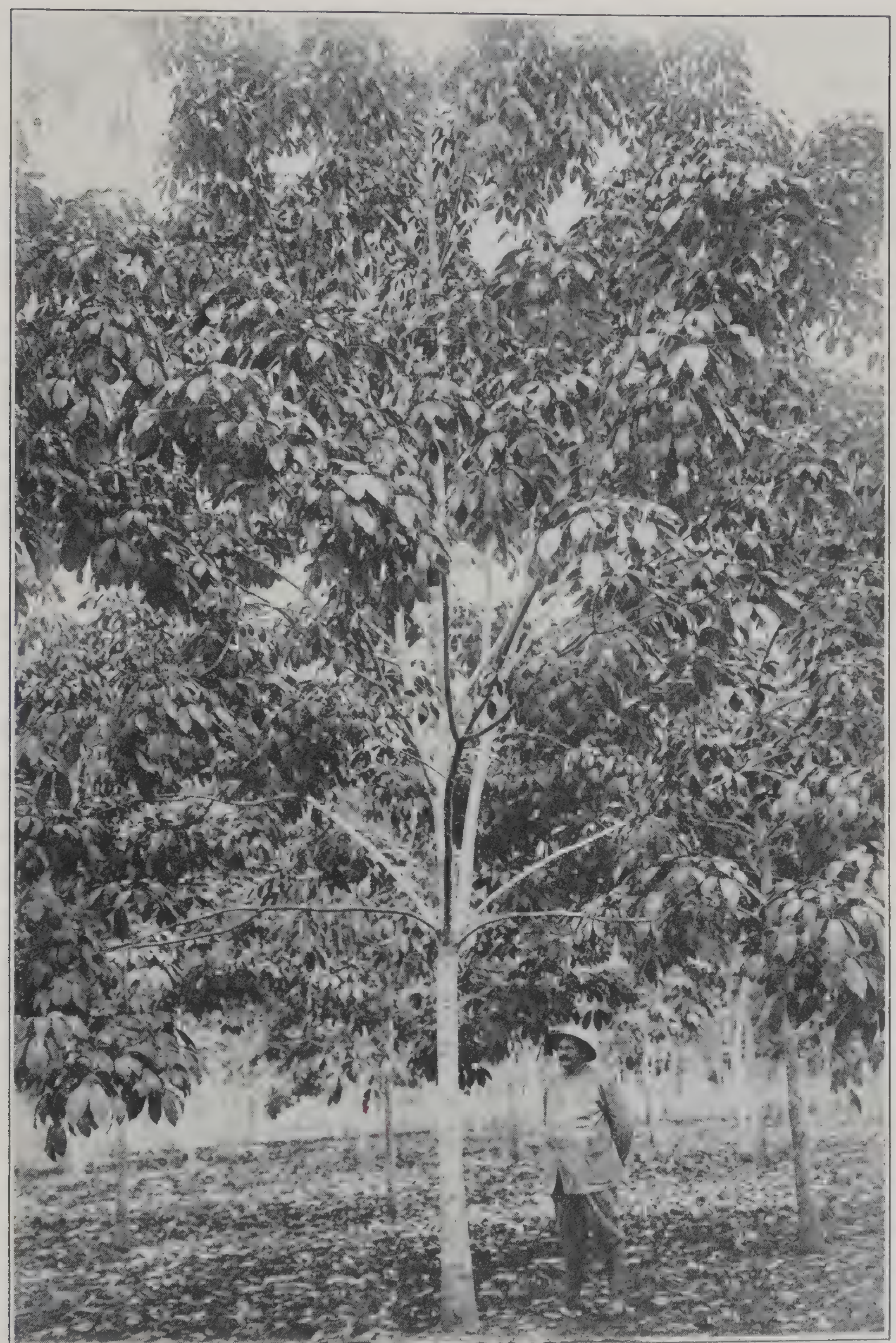
[a] Estimated.

In comparison with the above table the following estimate of the world's production and requirements for the next few years may be of interest to the prospective planter.

TABLE II.—*Estimate of the world's production and requirements of rubber.*

| Year. | Production. | | | | Requirements. |
|---|---|---|---|---|---|
| | Plantation rubber. | Brazil. | Other countries. | Total. | |
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| 1917 | 175,000 | 40,000 | 20,000 | 235,000 | 230,000 |
| 1918 | 205,000 | 40,000 | 20,000 | 265,000 | 260,000 |
| 1919 | 230,000 | 40,000 | 20,000 | 295,000 | 290,000 |
| 1920 | 254,000 | 40,000 | 20,000 | 314,000 | 31?,000 |

Here it will be noted that most of the world's production of rubber is already derived from plantations, which, it may be



Para rubber, 3 years 9 months old, under clean culture. Balactasan Estate, Basilan.

(*a*) Jungle clearing for rubber after the first burning. Basilan Plantation, Basilan.

(*b*) Para rubber in the nursery about ready for planting in the field. Basilan Plantation, Basilan.

said parenthetically, for all practical purposes are all located in the Old World Tropics. Brazil furnishes most of the rubber collected in the forest, and considerable quantities are also exported from Africa. The production of rubber from the native forests has apparently reached its maximum and now remains at a standstill. At any rate such gradual increases as may take place from this source are too slight to affect the rise or fall in market quotations for rubber. If the estimates of the production and requirements are correct there would seem to be no need for fear of any great change in the price of crude rubber during the next few years. To be sure, we can never know what day synthetic rubber may be produced at a cost that would spell ruin to the planter. However, this is a risk that is taken by investors in many other agricultural and industrial enterprises and it should scarcely deter any one from going into rubber growing.

In considering the Philippines as a possible future source of rubber, it is well to recall that in 1916 the United States imported 115,609 tons of rubber. In this connection, the following excerpts from an editorial that appeared in the India Rubber World, Vol. 55, No. 4, 1917 (New York), is also of timely interest:

> It is an indisputable fact that the future of the great American rubber industry, which uses two-thirds of world's production of crude rubber, rests with the British government. There is not enough Para rubber to supply the wants of this country, even if every pound of it came here, and all the rubber grown in the Malay States, Sumatra, and Java is completely in the hands of England and Holland. The British Consul General in New York is able to satisfy present requirements, and while it is unlikely that England and Holland would deny such an important customer as the United States, there is always that possibility * * *. Consul General Clive Bayley, however, is discreetly silent regarding the future policy of the allies with respect to crude rubber imports as affected by the Paris Convention, although the Foreign Trade Council, the Merchants Association of New York and the American Manufacturers' Export Association are all making inquiries and have lodged pertinent questions with the administration at Washington. Certainly this irksome situation, together with England's contemplated protective tariff, holds possibilities that may prove detrimental to American interests. Viewed in this light the imperative need of an adequate supply of rubber grown within our own borders as soon as possible becomes more than ever apparent.

If this was needed the present world war has so amply demonstrated the imperative need of self-sustentation of a nation that this fact requires no further argument. In this instance then from whence is our supply of crude rubber to be derived?

Investigations have been made relative to the possible culture of guayule in the southwestern part of the United States, and

while some rubber might be obtained from this source, yet the production of rubber from this plant under cultivation on a large scale so far does not appear promising. At best rubber production on continental United States will probably always be an insignificant feature. The frequency of typhoons precludes the possibility of rubber growing in Porto Rico and the Virgin Islands. The Panama Zone has never been mentioned as a suitable rubber country so far as the writer is aware, and in any event the area is limited. It is true that Hawaii has planted Ceara rubber in a small way, but there also rubber production is not likely to assume great proportions.

There remains then the Philippine Islands.

Here the soil and rainfall favor the growth of Hevea on a very large area of the Archipelago, though the typhoon belt reduces to a very considerable extent the territory where rubber growing is practicable. Southern Palawan excepted, all the islands north of Mindanao are for this reason unsuited to rubber.

So far as can be learned there seems to have been no attempt by the Spaniards to grow rubber in the Philippines.

During the early years of the American occupation the various rubber-producing plants already referred to were introduced from time to time and planted here and there throughout the Islands. Unfortunately careful inquiries as to the requirements of these species were not made prior to this work, and much of the material was planted in localities climatically unsuitable to rubber and therefore lost.

In the region adapted to rubber, the principal efforts to plant rubber have been made at Basilan.

Mr. C. F. Miller, now manager of the Balactasan Plantation, Basilan, and Dr. W. J. Strong, Zamboanga, seem to have been the first to plant Para rubber on a plantation basis in the Philippines. In 1906 and 1907 Mr. Miller set out 2,000 Para rubber seedlings in Lanote, Isabela, Basilan. However, owing to inadequate capital the plants were not properly cared for and most of the trees were lost. According to Mr. Miller about 150 Para rubber trees still remain of this plantation and notwithstanding neglect, some of the trees measured 120 centimeters in circumference 1 meter above the ground in June, 1917. The trees, which have never been tapped, are now the property of Mr. F. C. Bader. So far as known they are the largest Para rubber trees in the Philippine Islands.

The first commercially successful venture in rubber culture was made by Dr. W. J. Strong, Zamboanga. Like Mr. Miller, after first attempting to grow Ceara and Castilloa, Dr. Strong

planted several hectares to Para rubber in 1906 and 1907, also at Isabela, Basilan, a few kilometers from Lanote. The growth of these trees demonstrated the possibilities of rubber in Basilan to the satisfaction of prospective investors, who together with Dr. Strong organized the Basilan Plantation Company. Until quite recently this plantation remained under the management of Dr. Strong, who gradually extended the original Para rubber planting until in 1917 the plantation included 72,000 Para rubber trees which have made good progress. When the writer visited this estate in April, 1917, about one-tenth of the trees were being tapped. A little less than 25,000 kilos of rubber was produced last year. (Pl. VII.)

The Balactasan Plantation was started four years ago by Mr. John Spirig, Zamboanga. This plantation is located east of the Balactasan river a few kilometers east of Isabela, also on Basilan. The plantation includes 17,000 trees in excellent condition. (Pls. IV and V.)

Relative to the growth of rubber on Basilan Mr. Miller has furnished the following statement of the average girth of the trees on the Balactasan estate during the past year, at a height of 90 centimeters above the ground: Girth April 28, 1916, 26 centimeters; October 28, 1916, 31 centimeters; January 28, 1917, 35 centimeters; April 28, 1917, 40 centimeters. At this last date the trees were 3 years and 8 months old.

According to Mr. Spirig, on land occupied by cogon on secondary jungle the cost of bringing a hectare of rubber trees into tapping, including overhead expenses, exclusive of the cost of land and buildings, amounts to about ₱300 on an area of 80 hectares.

In connection with the above statements and what presently will be said about the rainfall requirements of rubber the following rainfall records taken on the Basilan Rubber Plantation are of interest.

TABLE III.—*Rainfall in the Basilan plantation, Basilan.*

| Month. | 1911 | 1912 | 1913 | 1914 | 1915 | 1916 |
|---|---|---|---|---|---|---|
| | *mm.* | *mm.* | *mm.* | *mm.* | *mm.* | *mm.* |
| January | ---------- | 127 | 76.7 | 36.8 | 68.5 | 487.6 |
| February | ---------- | 48.2 | 27.9 | 19 | 12.7 | 125.7 |
| March | ---------- | ---------- | 196.8 | 29.2 | 50.8 | 121.9 |
| April | ---------- | 57.1 | 212 | 180.3 | 60.3 | 68.5 |
| May | ---------- | 87.3 | 194.3 | 218.4 | 533.4 | 226.5 |
| June | ---------- | 300.9 | 440.6 | 312.4 | 410.7 | 306 |
| July | 100.3 | 359.4 | 265.4 | 254 | 584.7 | 242.5 |
| August | 174.4 | 163.8 | 248.9 | 68.5 | 259 | 429.2 |
| September | 130.5 | 111.7 | 289.5 | 264.1 | 286.2 | 247.6 |
| October | 319.7 | 436.8 | 429.2 | 144.7 | 326.3 | 721.8 |
| November | 6.3 | 101.6 | 162.5 | 128.2 | 247.6 | 222.2 |
| December | 110.7 | 49.2 | 163.8 | 128.2 | 584.2 | 391.6 |
| Total | 841.9 | 1,843 | 2,707.6 | 1,783.8 | 3,424.4 | 3,591.1 |

The following mean monthly and annual rainfall records from various points in the Philippines where rubber culture is possible have been copied from "Annual Amount and Distribution of Rainfall in the Philippines," by the Rev. Miguel Saderra Masó, Assistant Director of the Weather Bureau, Philippines.

TABLE IV.—*Mean monthly and annual rainfall in the Department of Mindanao and Sulu.*

| Month. | Municipalities and provinces. | | | | | |
|---|---|---|---|---|---|---|
| | Dapitan, Misamis. | Caraga, Davao. | Cotabato, Cotabato. | Davao, Davao. | Isabela, Basilan. | Jolo, Sulu. |
| | *mm.* | *mm.* | *mm.* | *mm.* | *mm.* | *mm.* |
| January | 118.4 | 294.8 | 98.8 | 110.2 | 54.4 | 89.1 |
| February | 123.3 | 402.4 | 88.8 | 141.6 | 89.2 | 122.4 |
| March | 55.7 | 270.3 | 68.1 | 164.2 | 58.2 | 85.2 |
| April | 110.2 | 148.5 | 164.9 | 190.3 | 89.2 | 118.2 |
| May | 70.9 | 203.7 | 218.5 | 252.8 | 108 | 160.2 |
| June | 117.7 | 103.6 | 237.3 | 234.2 | 210.6 | 203.3 |
| July | 151.6 | 142.7 | 292 | 208.9 | 208.4 | 172 |
| August | 89.3 | 75.7 | 271.8 | 207.4 | 205.8 | 170.4 |
| September | 141.6 | 67.4 | 248.6 | 203.6 | 201.6 | 184.4 |
| October | 246 | 128.4 | 255.1 | 242.3 | 261.7 | 222.9 |
| November | 369.7 | 171.9 | 231.7 | 176.4 | 168.4 | 193 |
| December | 277.4 | 422.6 | 133.5 | 208.8 | 138.6 | 144.8 |
| Total | 1,871.8 | 2,432 | 2,309.1 | 2,340.7 | 1,794.1 | 1,865.9 |

It would appear then that in the territory in question, the rainfall is satisfactory for rubber both as regards quantity and distribution.

Within the limitations set forth in the paragraph on climate and soil, rubber may be grown in Mindanao south of a line drawn from Baganga on the east coast of the island to Cagayan on the north coast, in Basilan, in the Sulu Archipelago, and on the southern half of Palawan. Owing to the prevalence of typhoons the islands to the north of Mindanao are unsuited to rubber. Planted there rubber would be foredoomed to failure from the start.

Naturally not all the land in the region recommended for rubber is suitable to rubber plantations; on the other hand, there are large bodies of land that are well adapted to this crop, and properly developed the rubber exports from this region should play no inconsiderable part in the exports of the Philippines and in the imports of crude rubber into the United States. Most certainly it is a matter that deserves close investigation by American capitalists.

## CLIMATE AND SOIL.

Para rubber succeeds best in a still, damp atmosphere, with fairly abundant rainfall, 1,800 millimeters or more annually, of fairly equal distribution throughout the year. The tree may

be grown from sea level to an elevation of at least 700 meters. The wood of the Para rubber is very brittle and the tops easily broken, therefore rubber planting is not practicable in regions subjected to typhoons. Rich, friable, alluvial, loamy or volcanic and even sandy soils are well adapted to this tree, but heavy, clayey and sticky soils should not be set out to Para rubber. The tree is impatient of water standing about the roots. Poorly drained soils may be corrected by drainage and liming.

### DESCRIPTION OF THE PLANT.

The Para rubber, *Hevea brasiliensis* (Pl. IV), is a semideciduous tree said to attain a height of about 30 meters, and with a trunk 2 meters in circumference, of rapid growth and brittle wood, native of the river valleys of Brazil, extending into Peru. The leaves are trifoliate and bright green; the leaflets are lanceolate. The flowers, produced in terminal panicles, are small and inconspicuous, greenish to brownish and strongly scented. The seeds are large and have a high oil content. The latex from which rubber is obtained is found in the bark of the tree. Among other economics related to the Para rubber may be mentioned the cassava, the castor-oil plant, and the Ceara rubber, already referred to.

### PROPAGATION.

Some years ago when rubber was first planted little or no attention was paid to seed selection, and one rubber tree was considered to be as good as another. However, a close study of the latex yield of individual trees soon disclosed the fact that there is very great variation in the yield of rubber as well as in other purely botanical characteristics of the different trees.

Rubber planters should accordingly make an effort to secure seeds from the best strains obtainable abroad, and after a plantation has become of tappable age records should be kept of the behavior of the trees and seeds planted from the best latex yielders.

The seed of Para rubber retains its viability for a short time only unless carefully stored and it is best to plant it as soon as it is ripe. If immediate planting is impractible the seeds should be packed away in slightly dampened charcoal or clean sand.

The land for the nursery should be thouroughly grubbed and cleaned of all stones, roots, and other trash to a depth of not less than 35 to 50 centimeters.

In order to insure good drainage to the plants, the soil should be thrown up in beds 1.5 meter wide, about 10 to 15 centimeters above the level of the ground. If the seeds are of good quality,

so that a good germination may reasonably be expected, the seeds may be planted direct in the beds, if not it is best to place the seeds in a shady place on a layer of moist sand and keep them covered by damp gunny sacking. The viable seeds will then germinate. The seeds should be examined once a week until all the viable seeds have germinated and all that show signs of germination should be planted in the seed bed at once.

Whether or not the seeds are planted direct in the seed bed or germinated as described and then planted, they should be spaced 15 to 18 centimeters apart and covered with about 1 to not more than 2 centimeters of soil. The seed should be planted so that the hilum faces downward, or the germinated seeds so that the root points downward.

Ordinarily watering of the seed beds is not necessary, but if the seed is planted during a dry period the seed beds should be thoroughly watered after the planting. Then, in order to prevent evaporation and save expense for subsequent watering it is well to mulch the seed beds with a thin layer of grass or rice straw to shade the ground.

The plants are benefited by the nursery being lightly shaded during the first six weeks after the planting of the seeds, but this is not essential.

If the plants have been grown under shade this should gradually be removed a month previous to setting the plants in the field in order to acustom them to the full exposure of the sun. Aside from being watered as the need therefor arises, the work in the nursery subsequent to planting the seed until the plants are ready for setting out in the plantation consists of an occasional weeding.

The above-described method (Pl. V, *b*) is the one commonly used in propagating rubber, and it is the most economical. However, while this is more expensive, and more care and attention is required in rearing the plants, the seeds may also be planted in bamboo joints or baskets and the plants set out in the field, the bamboo joint being split with a bolo (cutlass) and the plant set out, taking care not to break the ball of soil. Plants in baskets may be planted without removing the basket.

## CLEARING.

The lands available for rubber in the Philippines are covered with virgin or secondary jungle or cogon, *Imperata cylindrica*, in Java and the Federated Malay States referred to as lalang or alang-alang. The virgin jungle land is of course the most fertile, and in the early days of rubber planting it was considered

superior to the cogon land. However, experience has taught that on virgin jungle land rubber is subjected to attacks from *Fomes lignosus*, a parasitic fungus which develops on the jungle stumps that may remain after the clearing, from which the fungus invades the Hevea. This fungus is absent in the cogon lands; therefore, where other advantages are equal, the cogon is considered to be preferable to virgin jungle for a rubber plantation.

Where the vegetation is virgin or secondary jungle, the trees and shrubs should be cut down and burned during the driest part of the year (Pl. V, *a*) and all the smaller stumps taken out and burned together with remaining logs and the land plowed. On virgin jungle land there will be more or less stumps that are too large to remove economically until the smaller roots have decayed, but these should be dynamited and burned as soon as they can be removed at a reasonable cost, usually within 3 years, as otherwise the stumps will be a source of danger as a breeding ground for fungi as long as they remain in the field. The ideal way would be to clear the land of all stumps before planting the rubber.

The cogon land is most easily handled by burning the cogon and then plowing and cross-plowing the land and planting patani as a cover crop to choke out the cogon preparatory to planting the rubber. If it is desired to save the humus, this may be done by cutting the grass and piling it in rows, between which the land is plowed, which of course should be planted to patani.

It is doubtful whether very steep hillsides can be profitably planted to rubber, where the collection of latex would be more expensive than on flat and moderately sloping land. The steepest hillsides might to greater advantage be planted to coconuts, which will succeed well under the same soil and climatic conditions as rubber, and the harvesting of which could be attended to more economically than that of rubber under the aforementioned conditions.

If there is any danger of the flat lands being flooded there should be ample surface drains for the removal of the rain water. On sloping land liable to erosion the land should be terraced, or at least drains or trenches dug at right angles to the slope every few meters apart to prevent soil wash. This should be supplemented with the planting of legumes to retain the soil during heavy rains.

## STAKING AND PLANTING.

Since the yield of rubber is determined by the total girth attained by the trees per hectare it follows that the best dis-

tance at which to space the trees is that which produces the greatest girth per hectare in the long run. Rubber culture is still so young an industry that the ideal distance has not yet been determined, and the various distances used by planters differ considerably. Then again, rubber is set out equidistant according to the square system, or in rows spaced wider apart than the trees in the row. This latter method is especially recommended if it is desired to grow catch crops between the rubber while the plants are young. Both for maximum production of rubber during the young stage of the plantation and for the suppression of weeds it has been found best to space the young plants closer than they are ultimately to grow, with the intention of thinning the trees as they become crowded.

Four and a half meters is now generally recognized as the shortest allowed distance where the square system of planting is employed. Where the rubber is planted in rows the minimum distance between the trees in the row employed is 3.6 meters, the rows being 7.2 meters apart. Plate III well illustrates this method of planting rubber. However, the planters in the Federated Malay States have found that wider spacing is desirable for the best results and even the maximum distances given in Table V are sometimes used in that country.

The following table shows the number of trees required per hectare planted at various distances. Rubber should always be planted according to the square system or in rows; nothing is gained by planting according to the quincunx or the hexagonal systems.

TABLE V.—*Showing number of trees per hectare planted at given distances.*

| Distance apart, in meters. | Trees required per hectare. | Distance apart, in meters. | Trees required per hectare. |
|---|---|---|---|
| 4.5 by 4.5 | 494 | 3.5 by 7 | 408 |
| 5 by 5 | 400 | 3.5 by 8 | 357 |
| 5.5 by 5.5 | 335 | 3.5 by 9 | 317 |
| 6 by 6 | 277 | 3.6 by 7.2 | 394 |
| 7 by 7 | 204 | 4 by 8 | 312 |
| 8 by 8 | 156 | 6 by 12 | 137 |
| 9 by 9 | 123 | | |

The staking of the field is best accomplished in the following manner:

Before staking begins, take a wire sufficiently long to stretch across the field or block in its shortest dimension, and mark off on the wire with bright-colored paint the distance at which it

is desired to plant the trees, and put aside until the paint has hardened.

The easiest way to square off and stake a field is to fasten a carpenter's square on the top of three stakes at one corner of the field, and then with aid of the square put out lines of stakes—the stakes being placed at the distances it is desired to plant the trees—so that they intersect at right angles at the point of the square. Then move the square to the last stake in one of the lines, and place it so that one of the sides of the square is exactly in the line and that the other side points toward the field. Now sight and stake off another line along this side of the square and again move the square to the last stake in the line last staked and proceed with the staking as already described. If the work has been carefully performed, the first and the last staked lines should meet each other at right angles, which may be ascertained by placing the square in the fourth corner. The rest of the staking of the field with the aid of the wire previously prepared is now a simple matter. Beginning at the first corner, stretch the wire across the field between the first two stakes that are opposite each other, and drive a stake into the ground beside each mark on the wire; when the line is staked move the wire up to the next two stakes opposite each other and proceed as directed until the entire field is staked.

As an aid to put the young plants accurately in the place of the stake the planting board (fig. 4) will be found a convenient implement. This is used as follows: Before digging the hole for the tree put the planting board so that the tree stake fits in to the central notch; then drive two stakes into the ground so that they fit into the end notches of the board; in setting out the plant place the planting board so that the stakes fit into the end notches and place the plant in the central notch and proceed to fill up the hole with soil.

The size of the hole needed depends upon the character of the soil. If the soil is of good quality and not too compact a hole 35 to 40 centimeters wide and 50 centimeters deep is sufficient for ordinary-sized plants, but particularly if the land is heavily interlined with laterite or otherwise hard and gravelly it should be made larger, say not less than 60 centimeters each way. In exceptional cases dynamiting the holes may be advisable. It is well to remember that it is better to make the holes too large than too small.

The Para rubber seedlings are ready for transfer from the nursery to the field any time after they are 10 months old and

up to the age of 18 months; when older than this they become too large for convenient and economic handling, also the trunks of trees grown from old stumps frequently become bent owing to the thick stump the top of which is difficult to callus and heal. In other words, the young plants should be about 1.5 centimeters in diameter at a height of about 30 centimeters above the ground, or so old that the stem is brownish and rough up to a height of about 50 or 60 centimeters.

If there is a marked dry season in the locality in question care should be taken to have the plants set out sufficiently early during the rainy period to allow them to establish themselves well before the advent of the dry season.

When everything is ready for planting the tops should be pruned back to a little below the demarcation between the smooth, green growth and the older wood which is rough and brownish. The plants should be dug and handled carefully without being torn or bruised; all injured roots should be cut off above the injury with a sharp knife or pruning shears and the cut tarred. The plants should preferably be transplanted during rainy

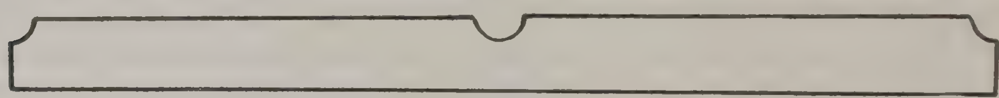


FIG. 4. Planting board.

weather, and the roots should not be allowed to dry from exposure in the air during the transfer from the nursery to the plantation. Rather than to set out the plants so that the roots are bent or twisted on plants of ordinary size it is well to prune back the tap root to a length of 40 or 50 centimeters and the laterals correspondingly shorter. All weak and imperfect plants should be rejected. In planting, as already stated, it is well to use a planting board in order to place the trees in proper position. The hole should be filled with surface soil, carefully worked in and packed between the roots, leaving no air spaces. In common with many other plants the Hevea is very impatient of too deep planting. It is therefore important that the plants are set no deeper in the hole than they grew in the nursery; in fact in order to allow for the settling of the loose soil in the hole it is best to set out the plants so that the demarcation between the stem and the roots while covered with soil is about 3 to 4 centimeters above the general level of the land.

## FIELD CULTURE.

If no catch crops are to be grown between the rubber, the land should be planted to a cover crop immediately after the

rubber trees are planted, in order to assist in suppressing the weeds and to enrich the soil. If this is not promptly attended to it will be but a short time before the land is covered with weeds the destruction of which will require an extra outlay of money. The land might of course be kept clean by repeated cultivations but this is more expensive than to plant the land to a suitable cover crop.

There may be other plants equally as good or better, but in the Philippines it has been repeatedly demonstrated that the patani, *Phaseolus lunatus*, answers the purpose as a cover crop for rubber better than perhaps all other plants that have so far been tried. *Passiflora foetida* also makes an excellent cover crop but does not of course enrich the soil to the same degree as the patani.

If patani seed is available at a reasonable cost it is well to plant it at the rate of 3 seeds in hills 0.75 to 1 meter part, in rows 1 to 1.5 meters apart, as the plants will then rapidly cover the ground and choke out the weeds. However, if seed is scarce these distances increased by one-third to one-half will answer, though naturally it will take more time for the vines to run over the weeds. Two or three plowings along the rows of beans should be given the young patanis to assist them in getting a vigorous start in competition with the weeds.

After the cover-crop plants are well established the rubber may be either "ring weeded" or "strip weeded." In the former case the rubber trees should be gone over every three to four weeks and all bean vines and weeds cleared away in a circular space about 0.75 centimeter in diameter around the trees. Or, if desired, a strip of the land along the rubber trees may be kept clean by repeated hoeings and cultivation. Of these two methods the ring weeding is the most economical while the plants are small, say up to 2 years old. After this age the strip weeding is preferable. (Pl. VI, *a*.)

If the growth of cogon and other weeds appears to be heavy and difficult to cover by the patani and *Passiflora*, the rolling of the weed growth to break it down by a heavy roller, say of a weight of 500 kilos, will be found to be a great aid to the cover crop in subduing the weeds. Such a roller may be made on the plantation of yacal or some other heavy native timber. If necessary repeat the rolling of the land once or twice at intervals of 6 weeks to 2 months. The rolling does not injure the patani and the *Passiflora* but its effect upon the cogon is most remarkable and indeed must be seen in order to be appreciated.

As the rubber trees approach the age of three to four years

the shade becomes so dense that the patani and *Passiflora* can no longer maintain themselves, and the weeds are then apt to assert themselves if allowed to do so. The growth of weeds and the cover crop should then be cleared away and piled up to decay and the field plowed. After this the best and the most economical practice is to keep the land clean cultivated. (Pl. VI, *b*.) It should be remembered, however, that under clean culture, in order to be effective, the land must be cultivated once every two to three weeks at least, and pains should be taken to see that no weeds are allowed to bloom and go to seed. During the first month millions of weeds will seem to spring up after every cultivation, but if the work is faithfully attended to and no weeds permitted to go to seed, the weeds will be seen to decrease gradually after each cultivation until finally the expense for weeding will be reduced to a very insignificant figure. In fact some authorities maintain that considering the accelerated growth of the rubber under clean culture it pays to clean cultivate rubber from the very time when the plants are set out in the plantation. However this may be, still, on all except extremely rich soils, a leguminous cover crop during the early stage of the rubber plantation is believed to be the most advantageous in the long run, since no more nitrogen can be added so cheaply later by the means of green-manure crops, after the rubber trees have grown up and shade the ground.

After the trees have attained the size where they shade the ground well and so keep down the weeds, cultivation with this object in view becomes unnecessary.

In Hawaii arsenite of soda has been used very successfully as a weed killer in the Ceara rubber plantations.

Even if it is not desired for use in large practice the weed killer may be found useful in destroying weeds in fence corners and other places difficult of approach with the cultivation.

The spray is prepared and used as follows:

Dissolve 1 kilogram of arsenite in 40 to 70 liters of water according to the hardiness of the weeds.

It is said that arsenate of soda may be used as a substitute for the arsenite and in the same quantities.

If arsenite of soda is not available the arsenite of soda solution may be prepared in the following manner:

Put 1 kilo white arsenic, 2 kilos washing soda or sal soda, and 8 liters of water in a kettle and boil for 15 to 20 minutes or until the solution becomes clear. The clearing of the solution indicates that the proper chemical combination has been effected.

Dilute at the rate of 1 part of the stock solution to 14 to 24 parts of water, according to the hardiness of the weeds, and spray the weeds. As in spraying insecticides the spray should be applied in a fine mist, and not in excessive quantities so that it runs into the ground from the plants as accumulations of arsenic are poisonous to plants.

Nine hundred liters of spray are required per hectare, which in Hawaii is applied at a cost of ₱12 to ₱22 per hectare including material and labor. One application destroys all except the most hardy weeds on which the spraying is repeated once or sometimes twice before they are entirely killed.

In order to stimulate the trees to more rapid increase of girth some planters recommend that the young trees be "ringed" or girdled at a height of 2.5 meters from the ground when they are 18 to 20 months old in the field. Then after the trees have made a few growths or "flushes" the girdling is repeated one or two times above the first girdling up to a height of 3.5 meters. Topping has been tried with the same object in view but has not been found practicable, as the branches then frequently break off later.

### CATCH CROPS.

By catch or auxiliary crops we understand plants that are interplanted between the permanent crop plants and that are later removed as the permanent plants require more room. Catch crops are usually annuals, such as peanuts, corn, cassava, or they may be perennials such as coffee. In Hawaii roselle has been used as a catch crop between rubber with good results.

In the case of perennial catch crops only those should be planted that mature early. In utilizing coffee as a catch crop for rubber, which is a common practice in Java, only Robusta, Quillou, Canephora, Uganda, and Congo should be planted, which may be expected to produce a crop by the third year. Liberian, Excelsa, and related coffees are slower in coming into bearing; therefore they are hardly to be recommended as a catch crop for rubber.

Coffee can scarcely be recommended as an auxiliary crop where the rubber trees are set out equidistant less than 6 meters apart, or where the rows are less than 7 meters apart. The coffee should not be planted closer to the rubber trees than 2 meters.

Catch crops should never be planted so close that the rubber trees are injured in the course of their cultivation.

For cultual directions for various catch crops publications devoted to the particular crop in question should be consulted.

## YIELD.

Grown under congenial conditions the rubber trees should be ready for tapping when they are four to five years old. Generally speaking, a tree is considered large enough for tapping when the trunk has attained a girth of 40 centimeters at a height of 1 meter above the ground. As a matter of fact tapping is sometimes commenced even earlier on the lower part of the trunk that has reached the desired girth though this is scarcely to be recommended. Naturally the growth of the trees is somewhat uneven, and tapping is usually deferred until 75 per cent of the trees have reached a suitable girth.

The yield of rubber per hectare may be conservatively estimated as follows:

| Age of trees. | Kilos. | Age of trees. | Kilos. |
|---|---|---|---|
| 4 years | 110 | 8 years | 300 |
| 5 years | 140 | 9 years | 370 |
| 6 years | 180 | 10 years | 450 |
| 7 years | 240 | | |

In fact beginning with a yield of 200 kilos of rubber when the trees are in their fifth year, returns on well managed estates frequently exceed 600 to 700 kilos of rubber per hectare in the tenth year.

Ordinarily about 75 per cent of the output constitutes No. 1 rubber.

In connection with the figures quoted relative to yield the following Singapore market quotations for rubber under the date of March 8, 1917, published by the India Rubber World (New York) may prove of interest. All figures are given in kilos and U. S. currency.

| | Per kilo. |
|---|---|
| Sheet: | |
| Fine ribbed smoked | \$1.57 to \$1.64 |
| Good ribbed smoked | 1.31 to 1.56 |
| Plain smoked | 1.23 to 1.36 |
| Ribbed unsmoked | 1.24 to 1.26 |
| Plain unsmoked | .98 to 1.27 |
| Crepe: | |
| Fine pale | 1.59 to 1.62 |
| Good pale | 1.44 to 1.59 |
| Fine brown | 1.31 to 1.43 |
| Good brown | 1.14 to 1.32 |
| Dark | .94 to 1.18 |
| Bark | .72 to 1.06 |
| Loose | .61 to .87 |

These prices are of course subject to fluctuations from day to day, but from the outlook at present it seems unlikely that the price of rubber will drop to any considerable extent.

### TAPPING AND MANUFACTURE.

Rubber is grown for the sake of the coagulated latex, which is contained in the bark of the tree. The method of harvesting the latex is commonly referred to as tapping.

There are several factors that contribute to the successful operation of a rubber plantation. The profits derived from the enterprise are determined by the degree to which these requirements are complied with. One of the most important of all the operations in rubber culture is the tapping because, owing to the peculiar method of harvesting rubber, careful systematic work is here more urgent if a plantation is to continue profitable, than in most other crops. In the improper method of harvesting the crops of most other perennial plants the loss is usually confined to the season's crop, but the improper tapping of rubber will permanently affect the yield adversely for the years to come.

In order to produce the maximum yield of rubber over a prolonged period of many years the tapping should be so arranged and performed that once of tappable age the trees can be tapped continuously without disturbing their natural functions.

When we recall that it is the bark that contains the latex tubes and that most of these are placed near the cambium layer, it is clear that in order to produce a maximum flow of latex the wider the cut is made in the bark, the greater is the flow of latex. On the other hand we must also remember that the prompt renewal of bark with a smooth surface is necessary for subsequent tappings, and therefore the cambium should not be injured. It is therefore important that while the cut should be made as wide as possible the knife should not penetrate through the innermost layer of bark so as to expose the cambium layer and the wood. This would partly prepare the way for entrance of fungi, and then it would produce an uneven bark tissue that is more difficult to tap the next time than an even surface. Again, the yield of rubber depends upon the area of bark surface exposed over a given period of time; hence it is evident that the thinner the slice of bark shaved off each time the longer can the tapping continue without renewal of the bark, and the greater is the yield of rubber.

Other important considerations are to make the subsequent

diagonal cuts parallel with the first one and to make them of the same length.

The subject of tapping and all questions pertaining thereto is quite exhaustively discussed in the "Cultivation of Hevea," by Dr. P. J. S. Cramer, and the text is accompanied by a series of line drawings to elucidate the text that makes this a very useful book for the inexperienced tapper.

Various systems have been tried in tapping rubber, of which the best and most commonly employed are perhaps the half and the full herring bone.

Whatever system is used two cuts are made: The diagonal cut, which is made to open the latex tubes in the bark and produce the flow of latex; and the vertical cut or canal, which serves solely to convey the latex to the collecting cup from the diagonal cut, at the lower end of which is inserted a small spout of sheet iron pointing downward.

The half herring bone system is used on young trees. This is illustrated on plate VII, *b*. Here the diagonal cut continues over one-quarter or one-half of the circumference of the tree on one side of the vertical canal.

The full herring bone system is used on old trees. Here two downward diagonal cuts converge at the vertical canal through which the latex is conveyed to the cup.

A tree is rarely tapped above a height of 1.8 meters.

In the course of four years the bark has been renewed so that it is again thick enough for tapping at a given point.

Notwithstanding the short time rubber has been an agricultural crop a great number of tools have been devised and used for tapping. Among these may be mentioned the hollow chisel or gouge, the farrier's knife, the Jebong knife, the ones commonly used, and several others more or less complicated.

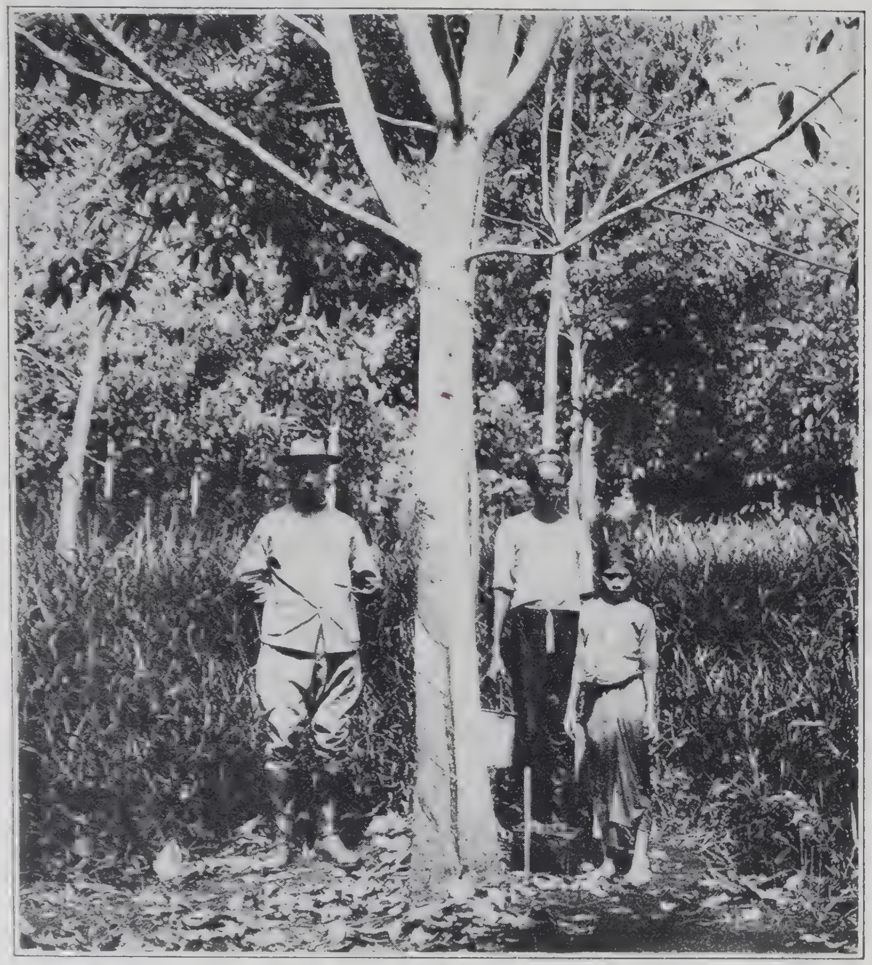
A good tapping tool should be simple in construction, contain as few parts as possible, be strong, and yet light and easy to manipulate, and the edge should be of good steel and be easy to sharpen.

Various types of cups are employed to collect the latex, of which those made of glass are preferable.

The tapping is performed during the early part of the day up to about 10 o'clock, after which the flow of latex is so slow as to make tapping unprofitable. Then the latex is collected and brought to the factory for manufacture into rubber. Many organic and mineral acids may be used as coagulants, such as acetic, citric, formic, sulphuric, and hydrochloric, but acetic acid is the one commonly used for this purpose in plantation practice.

(a) Para rubber, $3\frac{1}{2}$ years old, with patani for cover crop. Balactasan Estate, Basilan.

(b) Para rubber under clean culture, 3 years 9 months old. Balactasan Estate, Basilan.



(*a*) Para rubber, 5 years and 3 months old. Basilan Plantation, Basilan.

(*b*) Para rubber, $7\frac{1}{2}$ years old. Basilan Plantation, Basilan.

The latex is first strained. Acetic acid is then added to the latex in order to effect coagulation, which is done in shallow tanks of glazed tiles divided into long narrow compartments or pans for the manufacture of sheet rubber, or in deep tanks and the mass sliced for crepe. The coagulated soft mass is now passed through a roller to remove the water and made into sheets or crepe rubber as the case may be. Finally the rubber is dried or smoked before being packed for the market.

"The Preparation of Plantation Rubber," by Sidney Morgan, is recommended for study in connection with rubber manufacture.

### RUBBER PESTS.

The only serious disease of rubber that so far has appeared in the Philippines is *Fomes lignosus* (*F. semitostus*). This is a fungus that occurs in the native stumps that may be left in the plantation after the clearing of the jungle. Jungle stumps that may remain after the clearing should therefore be removed and burned as soon as practicable. Rubber trees that are attacked by the fungus should be dug up and burned if the affection is serious, and the soil exposed and covered with a liberal dressing of quicklime. If the affection of the fungus is slight the infested roots should be pruned off, the cuts painted with tar, and lime forked in about the roots. If several trees growing together become attacked it is well to dig a trench about 50 centimeters deep around the fungus-infected area, over which lime should be spread liberally and forked in.

Among the more serious diseases of the Para rubber that have appeared in the other rubber-growing countries of the Far East may be mentioned *Hymenochaete noxia*, the brown root disease; *Corticium salmonicolor*, the pink disease; *Phytophtora faberi*, which appears in four distinct forms, as stem canker, bark rot, abnormal leaf fall and diseased pods; *Botryodiplodia theobromæ*, the cause of dieback and failure to yield latex; and *Ustulina zonata* and *Poria hypobrunnea*, two diseases that attack the root system of rubber.

General sanitation of a rubber plantation should include the following:

1. The extraction of jungle stumps and all dead or seriously affected rubber trees.
2. The pruning of dead branches and fruits.
3. The removal and burning of all stumps, dead wood and prunings.
4. The tarring of all cuts incident to pruning.

5. Trenching around infected areas, on which lime should be spread liberally and worked in.

Rubber has been found subject to attacks of various insects in Ceylon, the Sunda Isles and the Federated Malay States, of which the most notable is probably *Termes gestroi.* However, this insect should not be a serious pest on a well ordered estate as the ants are readily killed by the fumes of arsenic and sulphur introduced into the nests by means of an "ant exterminator." (Fig. 5.) This apparatus consists of a charcoal burner and fume chamber, and a hand pump connected by a rubber hose.

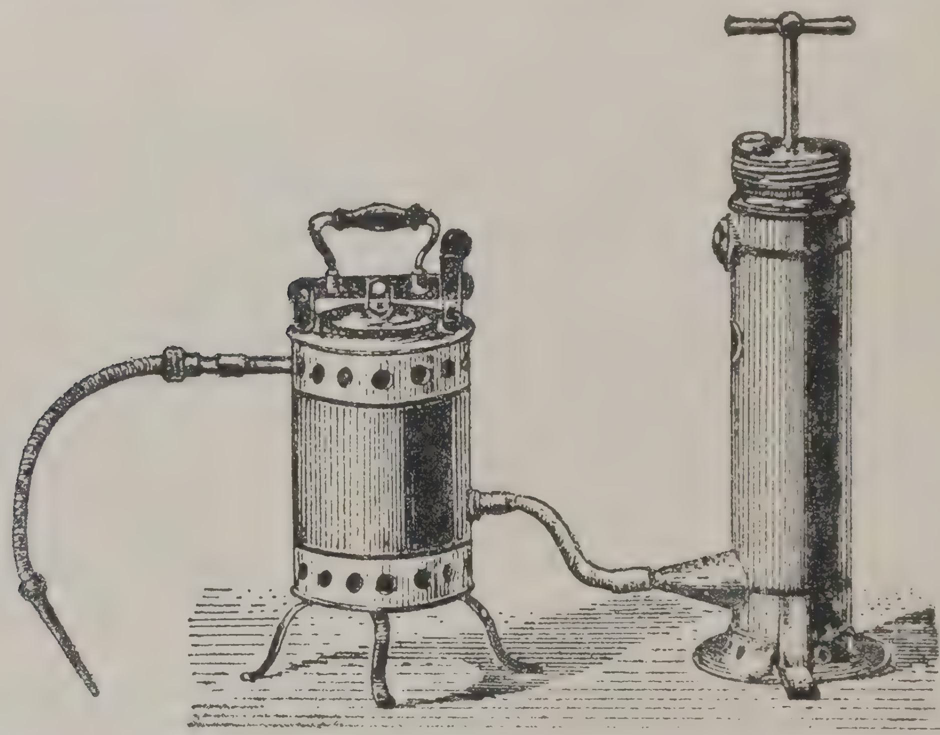


FIG. 5. Ant exterminator.

After the burner is lighted the air is pumped into the fume chamber from which, charged with the poisonous gas, it is forced into the termite nest. About a heaping spoonful of sulphur and arsenic is sufficient to treat a termite nest of ordinary size, and pumping for about 5 minutes is sufficient to introduce the fumes.

Ant nests may also be treated with carbon bisulphide poured into the nests through holes made with a crowbar, the holes being plugged with clay after the liquid has been poured in.

The damp climate of countries suited to the cultivation of rubber is unusually favorable for the rapid spread of diseases. Therefore it is doubly important that every precaution be taken to prevent the introduction of rubber diseases from abroad.

# SIMPLE LABORATORY APPARATUS.

By C. W. HINES, *Sugar Technologist.*

The importance of carrying on a careful control over the crystalization work in sugar factories is apparent to every sugarhouse superintendent since the success of a factory depends entirely upon this work. It is therefore of importance that he have at hand a convenient apparatus to accomplish these tests with the greatest despatch.

Herewith is a sketch of a simple apparatus which may be successfully employed in the absence of a small hand centrifugal to accomplish this work. This apparatus has been employed by the writer in both beet and cane sugar factories and on account of its simplicity of operation and effectiveness it is preferred in many cases to the hand centrifugal.

The apparatus consists of an ordinary glass fruit jar, preferably of a quart capacity. The zinc lid has a hole cut 2½ inches in diameter through which the funnel portion passes where it is soldered tightly. The upper portion of the funnel is approximately 5½ inches in diameter and is soldered to the upper can of the same diameter and approximate height. The upper can contains a copper or brass bottom with fine perforations. This is soldered in place at the junction of the funnel and upper can. A piece of ½-inch pipe bent at right angles enters the side of the cone and extends down slightly below the union of the lid and the funnel. The other end of this pipe terminates in an ordinary union coupling which is operated by hand. This coupling is arranged for attachment to another pipe of the same diameter which is securely attached to the side of the last number of the effect or to the vacuum pan. This tube extends about 6 inches from the evaporator and contains a valve which is operated only when the apparatus is in place.

To operate the lid should be screwed tightly to the lower jar. In the upper receptacle is placed the desired quantity of massecuite, usually from one to two pints. The apparatus is attached to the evaporator at the union of the ½-inch pipe, care

being taken that the union is air tight. The valve located on that portion of the pipe near the evaporator is opened which

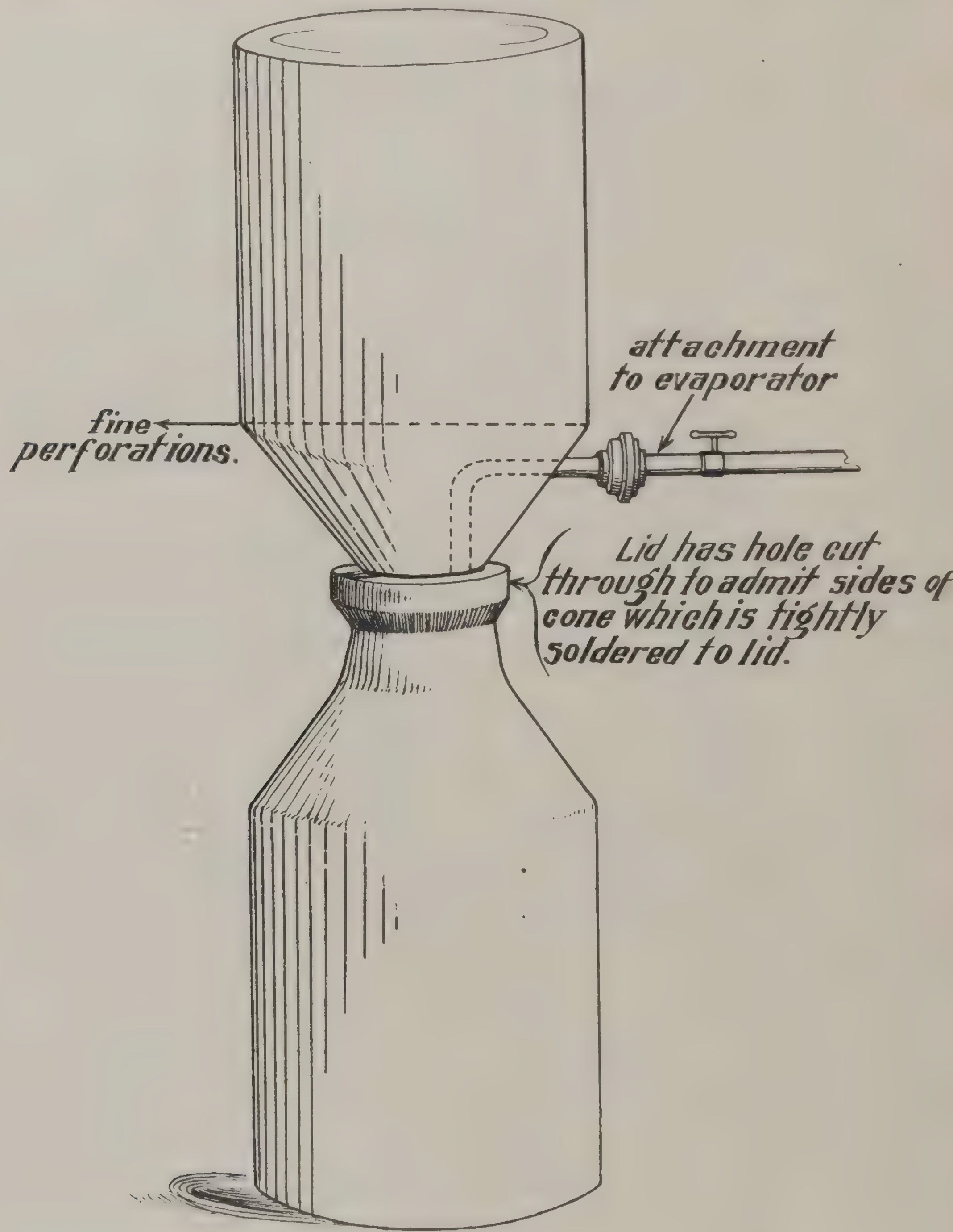



FIG. 6. A simple apparatus which may be used in the absence of a small hand centrifugal.

causes the air in the jar to be drawn into the evaporator and creates a vacuum in the jar whereby the molasses from the massecuite above flows at once into the jar.

# SOME CAUSES OF THE FAILURE OF THE MANILA CIGAR ON THE UNITED STATES MARKET AND A REMEDY.

By D. B. MACKIE, *Entomologist.*

Since the passage of the new tariff schedule admitting Manila cigars to the United States free of duty, the writer has been interested both in an official and personal capacity in studying the course of the Philippine product on that market.

During a period of seven years, the writer has had abundant opportunity to study this problem in all its various phases which include the course of the tobacco, through the regular channels of trade, from the time it is planted until it is in the hands of the consumer.

While a study of the problem shows that there are undoubtedly many factors which contribute to the present status of this product on the aforesaid market, in the following article it is proposed to deal only with the problems which have been officially called to the writer's attention. These are the control of the cigarette beetle and mold, each of which has been the cause of considerable complaint against the Manila product.

In order to be able to draw proper conclusions, the opinions of all interested parties have been solicited and include representations by manufacturers, dealers and consumers, and interested Government agencies. The writings of other authors who have dealt with this subject have also been carefully studied and have been liberally drawn upon.

Such information as is reported as coming from producers was obtained by conference with factory managers; that from dealers was furnished by sale managers who handle Manila cigars in the United States and from tobacco merchants whom the writer met at the Panama-Pacific Exposition; the opinion of the consumers covers the opinion of retail dealers and smokers in seventeen different States of the United States.

As the trade which this market engendered has been the direct cause of the problems with which it is proposed to deal, it is deemed advisable to give a short resumé of some of the causes

which have tended to bring these problems to the attention of the Government.

With the passage by the Sixty-first Congress on August 5, 1909, of the revised tariff schedule, the great markets of the United States were opened to many Philippine products hithereto denied entry, except by payment of an import duty. Among these were tobacco and its products.

By the new ruling there could be imported free of tax or surcharge, save the regular United States Internal Revenue tax on such articles, tobacco in the following quantities: Filler tobacco, 1,000,000 pounds; mixed filler and wrapper filler not to exceed 15 per cent, 300,000 pounds; cigars 150,000,000.

Under the old tariff, the trade in Philippine cigars reached its highest figure in 1909 when 2,696,000 cigars of Philippine manufacture were imported into the United States. In the short space of a year this number reached the unprecendented figure of 88,180,000,[1] an increase of 4,000 per cent. Before going into the matter, it may be well to give details as to the causes of what happened.

*Quantity of cigars exported to the United States and the average value per thousand.*

| Year. | Quantity of cigars. | Average value per 1,000. |
|---|---|---|
| 1908 | 1,365,000 | |
| 1909 | 2,696,000 | |
| 1910 | 88,181,000 | $50.74 |
| 1911 | 27,936,000 | 47.35 |
| 1912 | 71,973,000 | 43.52 |
| 1913 | 101,647,000 | 45.95 |
| 1914 | 56,205,000 | 42.71 |
| 1915 | 61,170,000 | 37.64 |
| 1916 | 111,478,216 | 36.47 |

To begin with, few dealers in the United States had dealt in Manila cigars to any extent. Secondly, the smoking public knew virtually nothing about them. Purchase prices were attractive and the cigars could be sold at an excellent profit. In short, here was an article with great possibilities.

What happened? Dealers in the United States, eager to avail themselves of the opportunities of an early market, placed large orders in Manila and by judicious advertising shortly created a boom in Manila cigars. To meet this demand the factories at Manila were taxed to the utmost. More orders were received than could possibly be filled. Work was rushed and too much attention was given to getting the greatest possible number of

[1] See Report of Insular Collector of Customs for 1910.

cigars on the market and obtaining the advantage of the then high prices.

The rate of production increased so rapidly that the export figures rose in one year to 88,181,000, a figure hithereto undreamed of. About this time things began to happen in the States. Advertising campaigns led the smoker in the United States to believe that the Manila product was a somewhat superior article. He anticipated that he was going to get something better than his ordinary nickel smoke for the same money. What he got was a cigar that was neither a credit to the maker nor to the dealer who sold it to him. Not to be fooled, he simply went back to his old smoke and gave the Manila cigar a wide berth. The boom broke and the bottom dropped out of the market for Manilas. The U. S. market being unable to assimilate these cigars, dealers in the States began to cancel orders and large stocks then in the States were stored. Whether or not they were stored in proper places is a matter of dispute. However, when they were opened a large percentage of them were found to be infested with the cigarette beetle, *Lasioderma serricorne,* and with a mold, which has been identified as *Aspergillus candidus.* Anxious to dispose of them for what they could get, these great stocks were auctioned off for what they would bring and become distributed all over the country. The acquaintance of many a smoker in the United States with a Manila cigar is limited to one of these smokes. This in its turn gave to the Philippine product the worst possible advertisement and dealt to the export trade therein a blow from which it has never made a healthy recovery.

This caused a general reaction against Manila cigars which caused the export figures for 1911 to fall to 27,936,000, a drop of 65 per cent. With a falling off in the trade a part of this poorer quantity of cigars that had resulted from haphazard methods became eliminated but still the complaint has been persistent that Manila cigars are received in the United States in a wormy and moldy condition.

## THE CIGARETTE BEETLE.

As the essence of all control methods is a thorough and complete knowledge of the pests under consideration, the conditions under which they develop, their habits, life history, and in fact everything that pertains to their economy and bionomics, it is essential that all problems covering these points be worked out and that the data be available for the development of future control methods.

Taking the pests in the order of their importance, to the cigarette beetle belongs first place. Though known to the trade as the "cigarette beetle," and here in Manila as "gorgojo," this species by no means confines itself to tobacco. Practically no tobacco manufacturer is familiar with it beyond the fact that he knows that it damages his cigars and that it is more prevalent some years than others.

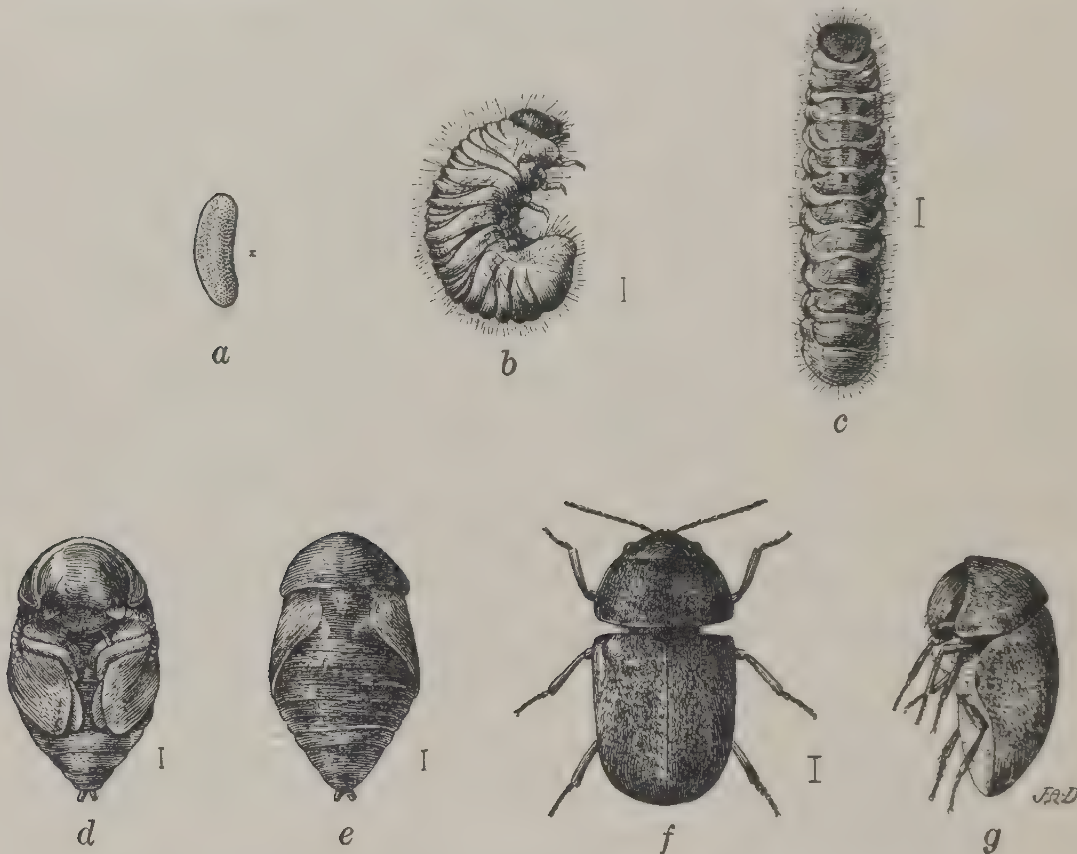



FIG. 7. Different stages of cigarette beetle (*Lasioderma serricorne*).

## LIFE HISTORY (FIG. 7).

*Eggs.*—The eggs are laid on the tobacco generally in some wrinkle or fold or wherever protected and are rarely laid on the smooth surface of the exterior of a cigar. They are of a rather opaque white and average 0.47 by 0.23 millimeter, being microscopic. They are laid singly, one female of this species laying comparatively few eggs. Twenty-seven is the highest number that the writer has noted as being laid by one individual. They are attached by a viscid secretion which on drying cements the eggs firmly to the tobacco.

C. R. Jones, formerly of this Bureau, gives the following tabulation which shows the variation in the period of incubation:

*Variation in incubation period of Lasioderma serricorne Fabr.*[a]

| Date laid. | Hatchings. First. | Second. | Third. | Fourth. | Variation in hatching. | Average period of incubation. |
|---|---|---|---|---|---|---|
| 1911. | | | | | *Days.* | *Days.* |
| May 12 | May 20 | | | | | 8 |
| May 14 | May 20 | May 21 | May 22 | | 2 | 7 |
| May 15 | May 20 | May 21 | May 22 | | 2 | 6 |
| May 17 | May 25 | | | | | 8 |
| May 18 | May 25 | | | | | 7 |
| May 18 | May 23 | May 24 | | | 1 | 5.5 |
| May 21 | May 27 | | | | | 6 |
| July 28 | Aug. 5 | Aug. 7 | | | 2 | 6.5 |
| July 29 and 30 | Aug. 4 | Aug. 5 | Aug. 6 | | 2 | 6 |
| Aug. 6 | Aug. 11 | Aug. 12 | | | 1 | 5.5 |
| Aug. 7 | Aug. 12 | | | | | 5 |
| Aug. 10 and 11 | Aug. 17 | Aug. 18 | Aug. 19 | Aug. 20 | 3 | 8 |
| Aug. 22 | Aug. 26 | Aug. 28 | Aug. 30 | Aug. 31 | 4 | 7 |
| Aug. 26 | Aug. 31 | Sept. 2 | | | 2 | 6 |
| Aug. 28 | Sept. 2 | Sept. 4 | | | 2 | 6 |
| Aug. 30 | Sept. 2 | Sept. 4 | Sept. 6 | Sept. 7 | 4 | 5.5 |
| Aug. 31 | Sept. 4 | Sept. 5 | Sept. 6 | Sept. 7 | 3 | 5.5 |
| Sept. 1 and 2 | Sept. 6 | Sept. 7 | | | 1 | 5 |
| Sept. 28 | Oct. 2 | | | | | 4 |
| Nov. 19 | Nov. 23 | Nov. 24 | Nov. 25 | | 2 | 5.5 |
| Average | | | | | 2.2 | 6.1 |

[a] The eggs used in these tests were laid by different individuals, but were kept under the same conditions, and the record shows all eggs that hatched.

From the experience of the writer the females lay for a period of six to ten days, gravid females under observation in no cases living longer than that period.

*Larvæ.*—The larva which emerges by gnawing through the shell, is, at the time of hatching, less than a millimeter in length. Its head is yellowish and the body translucent, whitish, and covered with fine hair. A much longer period is spent in this stage than is generally believed. Twenty-five specimens reared became full fed and transformed into pupa in periods varying from 151 to 170 days.

*Pupa.*—As the time approaches for the transformation, the larva constructs for itself a cell composed of frass and minute particles of tobacco and then undergoes its metamorphosis. This stage lasts on the average eleven days.

*Adult.*—The adult beetles are small and active, running about and spending considerable time in flight, being most active late in the afternoon and at night. They are attracted by lights. When disturbed they bend their heads and thorax forward, fold their legs and feign death.

There appears to be no seasonal brood, eggs, larvæ, pupæ, and adults being found in the same bale of tobacco.

*Feeding habits.*—It is unnecessary to go into details as to the feeding habits of this species, except such as may bear on control measures. Some authorities state that this species does not feed

during the adult stage. This is in a large sense true; however, this should not be construed to mean that the adult beetles do not, during the period of their existence, perforate much tobacco. A large part of the round holes which we find on long infested cigars are caused by emerging adults. On one occasion three beetles in 24 hours made no less than four borings through the wrapper and binds of a cigar to such an extent that it could not be smoked without being patched up to allow it to draw. However, in the general period of its activities during the adult stage it is believed that the damage done by adult beetles boring into cigars is insignificant.

In its larval stage the damage seems to vary with individuals and at times when they find a convenient field for operations they will eat out a chamber; at others they will bore from one cigar to another as if seeking more congenial feeding grounds. Like many other insects, this species reacts to a favorable environment.

It is an accepted fact that tobacco crops of certain years suffer much more damage than others. This fluctuation in the numbers of this species seems to be influenced largely by the amount of rain that falls during the growing season. After a year when the growing season is very rainy the leaves are thin and silky, a considerable percentage of their natural resins being washed off. The crop harvested after a very dry season is rich in natural resins, the stickiness of the leaves which is a characteristic of tobacco being much more pronounced. Thus the absence of this pest shows that the natural resins present in heavy tobacco acts as a mild repellent and offers another example of the predilection of the species for the lighter grades of tobacco.

## CONTROL.

In taking up the matter of control, it is well to consider the distribution of the pest. The species feeds on practically all kinds of tobacco, the product being attacked soon after it has been harvested. Thus it is present in the tobacco before it is baled and becomes baled with it, and is then distributed through the regular channels of commerce. In this manner each factory receives a new infestation in every bale of tobacco that is received. The damage done to baled tobacco is entirely dependent on the time which elapses before it is used. For this reason, the control of the beetle represents two distinct problems: (1)

its control in the unfinished product (baled tobacco); and (2) its control in the finished article of trade (cigars).

Without considering the damage wrought by the beetle to the baled product, it will readily be seen that its numbers in the factory would be materially reduced if the baled products were cleaned of the pest upon arrival. Thus manufacturers in considering control measures must make allowance for the fact that new infestation is a constant factor to be dealt with.

It is known that the beetle cannot enter boxed cigars that are prepared for sale in the ordinary manner. Therefore, if there is no living beetle in any form in the tobacco there will be no chance of future damage. To thus free cigars, it becomes necessary either that the tobacco from which cigars are made be cleaned of and be kept free from beetles, or that the finished product be treated in such a manner as to kill this pest in all its forms. As the beetles are constantly flying and breeding in and about the factory, laying their eggs wherever there is tobacco and as the factories of Manila are constructed in such a manner as to render the extermination of this pest impossible, any campaign along the lines of the first method is not feasible. The second will now be considered.

*Processes.*—In considering any process the susceptibility of the tobacco to injury from substances that would affect its aroma, color, flavor, or burning quality must be kept in mind. Considerable work has been done in Manila in the experimenting with various treatments for the killing of beetles, both by C. R. Jones and the writer. Much of this work failed because of popular prejudice and general lack of interest.

Work conducted in 1911 and 1912 demonstrated the utility of fumigation methods of controlling the beetle with carbon bisulphide and hydrocyanic-acid gas. It also brought out the fact that the general rank and file of factory managers are opposed to any method wherein any chemical is used, a prejudice which is unreasonable and not based upon actual facts.

It was with a view to improving existing methods and breaking down this prejudice that the writer again took up the work in 1914. At this time the idea of fumigating with a vacuum was conceived, the writer not knowing of the work of Sasscer and Hawkins in this line, and experiments early demonstrated its possibilities. Since then, it has been possible to show that fumigation with vacuum possesses the following advantages:

(1) A better permeation of the material is secured; (2) the vacuum renders the beetle more susceptible to the fumigant; (3) it kills the pest in all stages; (4) it reduces the time of the operation; and (5) it allows for the mechanical removal of the gas.

Since 1914, three vacuum machines for treating tobacco have been installed in Manila factories, two of these being for gas fumigation, while the third can be used for gas fumigation, heat-vacuum treatment, and for steaming tobacco. These machines have been used in treating baled tobacco, loose filler, and cigars both open and packed. Since their installation, over 30,000,000 cigars have been treated, most of which have been shipped to the United States.

The fumigant utilized in each case has been carbon bisulphide, $CS_2$. The method, while variable, is in general as follows: The cigars are packed in boxes and placed in the container (machine shown in figure 8 holds about 40,000 at once), the door is closed and the air exhausted to a 24 to 28 inch vacuum. The generator is then opened and the gas rushes in, permeating even to the smallest interstices of the product. The beetles, in whatever stage they may be, become distended, as the atmospheric pressure is removed. With the opening of the generator and the corresponding pressure the gas is absorbed directly into the respiratory system, causing death.

The time limit at which it is safe to assume that all beetles are killed will depend on the vacuum attained, the best results being obtained with the greatest vacuum. Some operators prefer to run their pumps till the vacuometer registers 24-inch and let the product remain subjected to the gas longer; others run the vacuum higher to 28-inch and lessen the time under the gas.

Actual work, under actual factory conditions, shows that the time taken to process cigars varies. Some prefer three hours and others less. With the machine shown in Fig. 8 the writer has had great success by placing the cigars packed in containers in the drum, reducing the pressure to 28-inch vacuum, injecting gas $CS_2$, allowing one hour contact with the gas, starting the pump, removing the gas and filling the chamber with air, and

then removing the product. The time in minutes occupied in this operation is as follows:

| | |
|---|---|
| Close fumigator | 1 |
| Exhaust air to 28-inch vacuum | 30 |
| Let in gas $CS_2$ | 4 |
| Expose to gas | 60 |
| Pump out gas | 30 |
| Let in air | 4 |
| Open | 1 |
| Total | 130 |

Upon letting the $CS_2$ into the vacuum from the container it is immediately vaporized. The amount let in in can be regulated by placing a definite amount in the container, one pound per

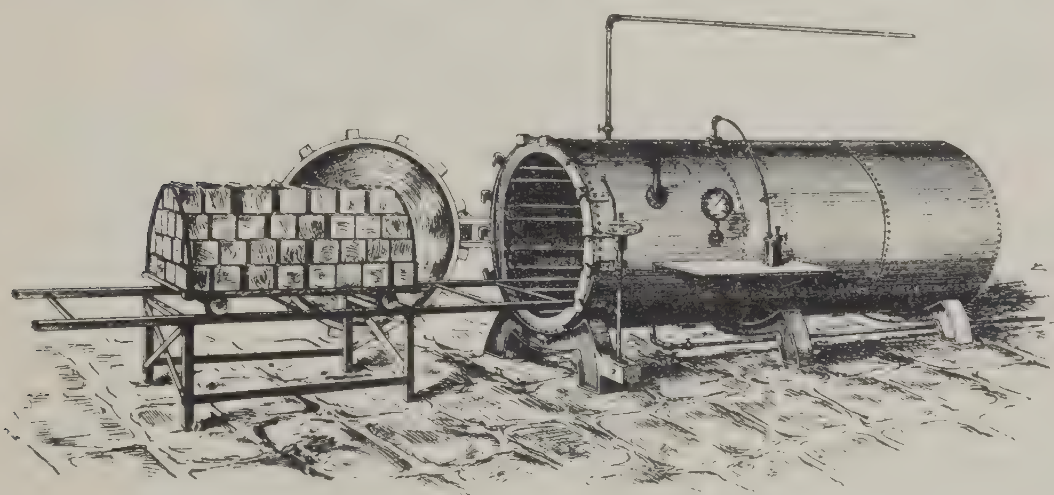


FIG. 8. Vacuo-fumigation chamber installed.

150 cubic feet having been found sufficient for all purposes. Future work will very likely show this amount can be reduced.

For tobacco loose in "manos" (bundles of 100 leaves) or in bales the same treatment will apply. It is generally considered best to impregnate baled tobacco and allow the gas to remain, instead of pumping it out. This shortens the operation and allows the gas to more thoroughly complete its functions. Baled tobacco impregnated with $CS_2$ will hold a large percentage of the initial amount absorbed and allow it to slowly escape, thus permitting a longer exposure to the gas and correspondingly greater efficiency.

A machine such as is shown in figures 8 and 9 was made in Manila and was constructed according to the following specifications:

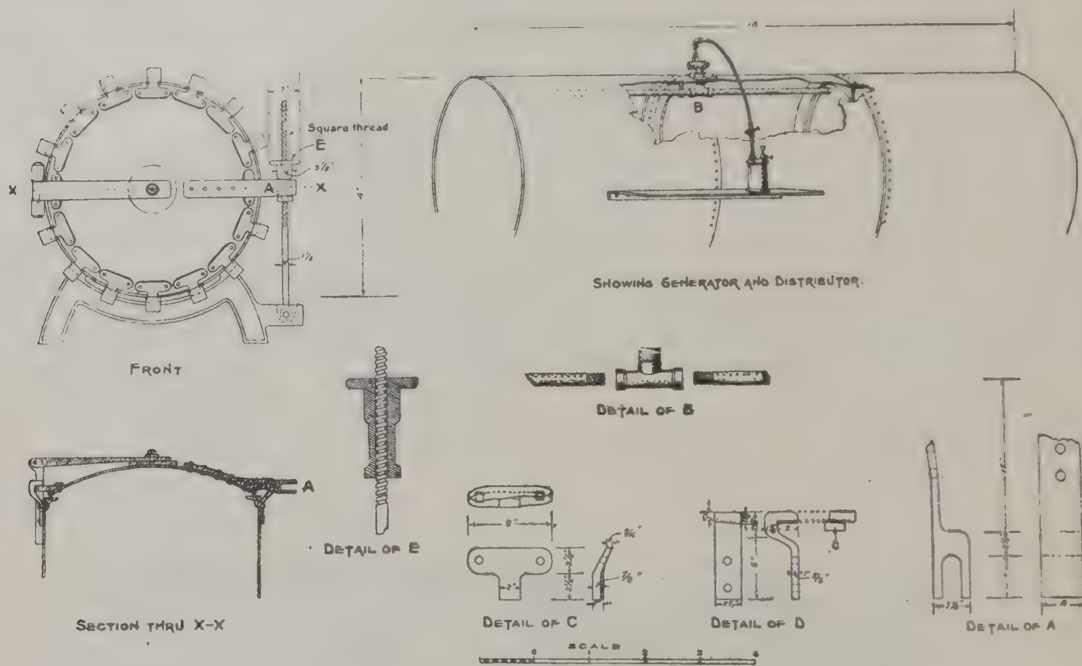



FIG. 9. Details of Vacuo-fumigation chamber.

Tank: Cylindrical, 4 by 10 feet, of $\frac{1}{4}$-inch boiler plate; two dished ends of $\frac{3}{8}$-inch boiler plate; one hung as a door from side hinge pin and closed through 12 wedge cleats by means of locking wheel and release; tank fitted with three valves and two cocks; chamber capable of sustaining a 28-inch vacuum with a loss of vacuum of not more than two inches per hour; chamber rests on three cast-iron stands.

Vacuum pump (fig. 10): Two water-jacketed cylinders; 6-inch stroke, and 4-inch bore (such a pump should develop a 28-inch vacuum in 30 minutes); chamber fitted with steam coil of $1\frac{1}{2}$-inch pipe, 130 feet in length; chamber equipped with standard vacuometer showing vacuum and corresponding boiling-point scale; generator cast-iron finished, as per plan (fig. 11); capacity, 100 cubic inches; chamber equipped with 30-inch gauge track 26 feet in length; track constructed of 2 by 2 by $\frac{3}{8}$-inch angle iron diagonally braced with the same material; two platform cars each 5 by 3 feet; wheels 4-inch in diameter with 2-inch tread and 1-inch flange.

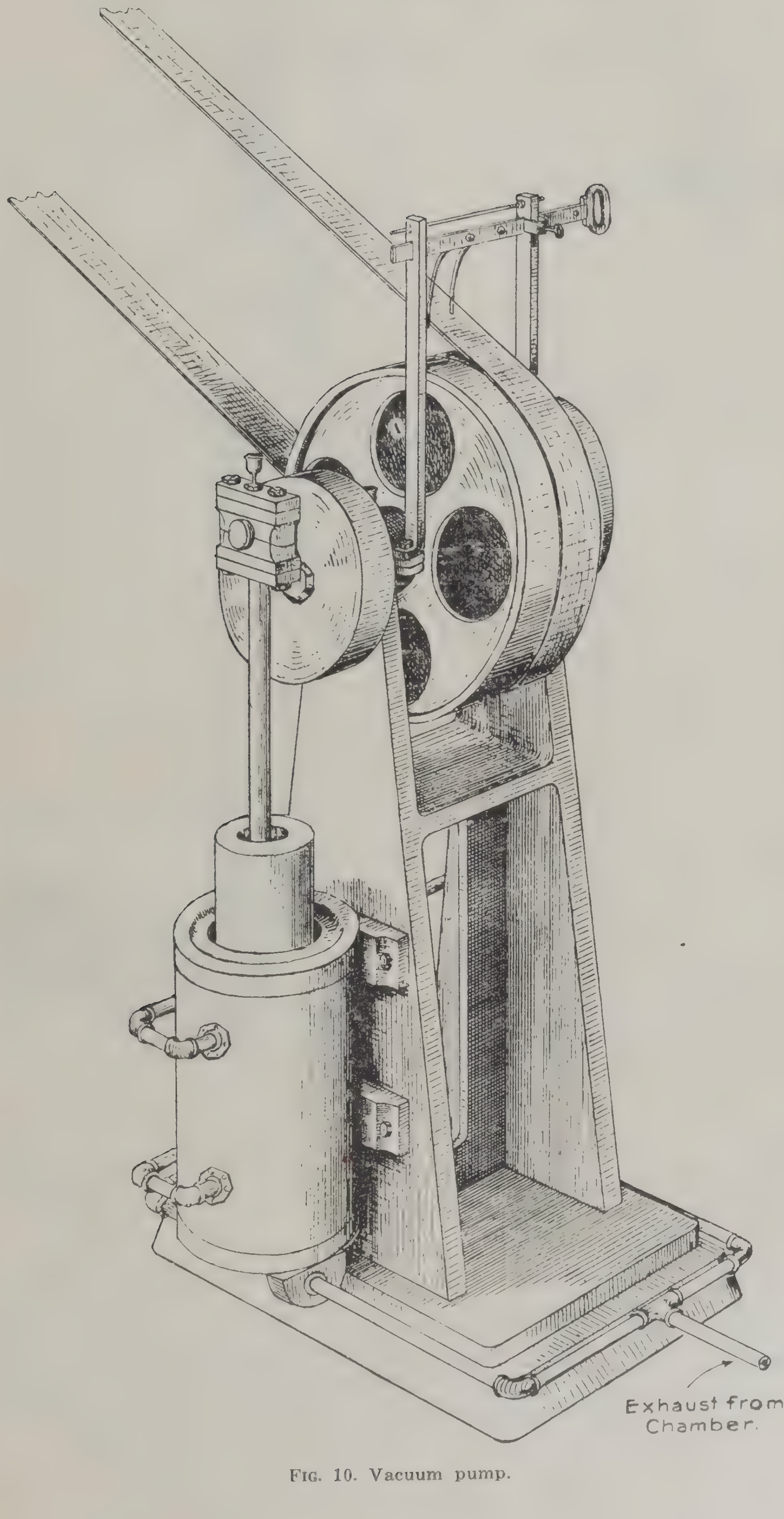



FIG. 10. Vacuum pump.

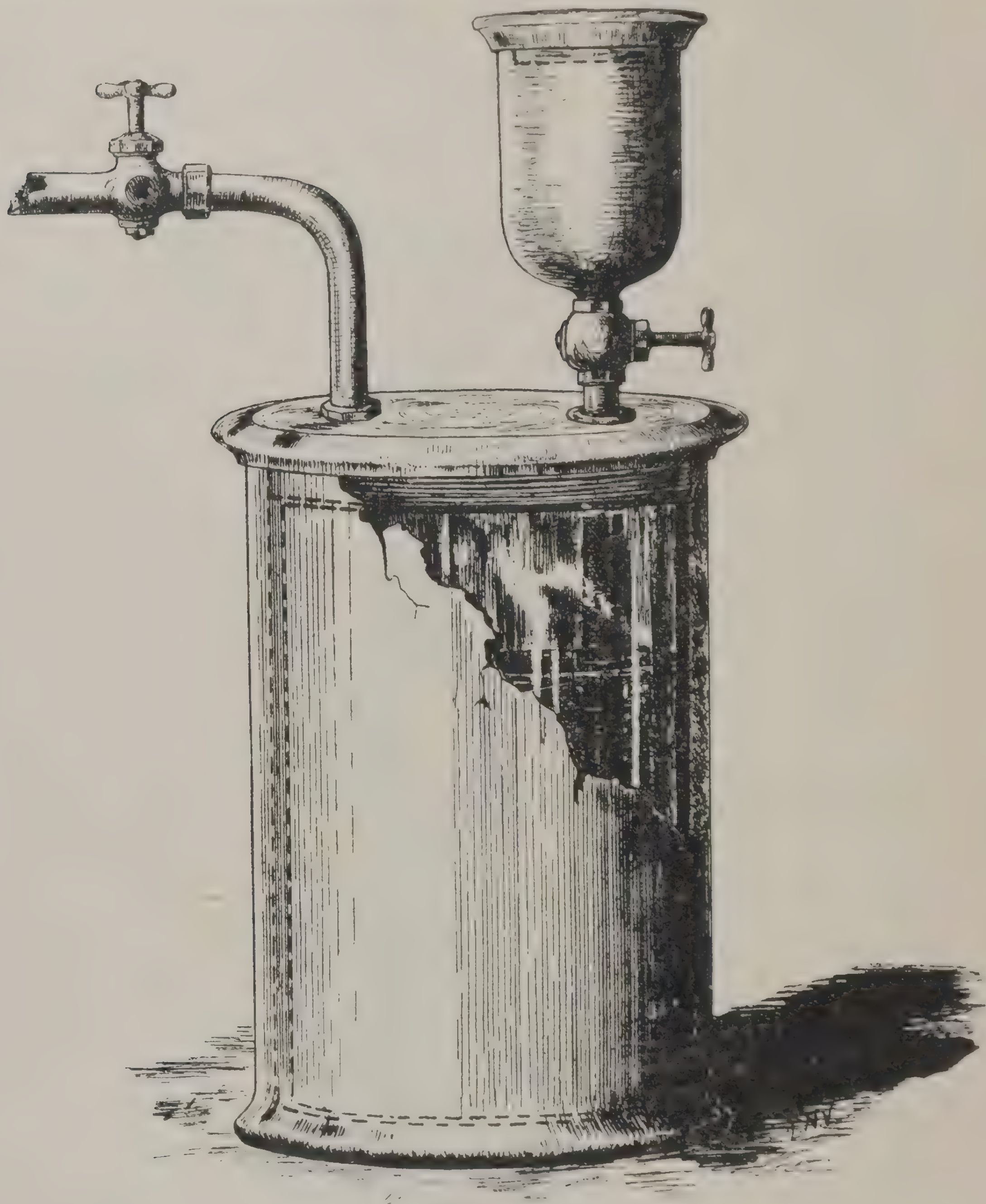


FIG. 11. Detail of generator.

The prices which now prevail are war prices and consequently higher than under normal conditions. Even with these abnormal prices, the machine should not cost over $1,250.

Process No. 2 which utilizes no chemicals whatsoever is a treatment worked out by the writer in an endeavor to meet the prejudices of the local manufacturers against the use of any chemicals. It is based upon the principle that the boiling point of any liquid is dependent upon the pressure. Consequently, as the pressure is removed, the boiling point is lowered.

*Temperature and pressure of steam for each half-inch vacuum.*

| Inches of vacuum. | Temperature. | Absolute pressure, per square inch. | Inches of vacuum. | Temperature. | Absolute pressure, per square inch. |
|---|---|---|---|---|---|
| | *°F.* | *Pounds.* | | *°F.* | *Pounds.* |
| 1 | 210.29 | 14.206 | 15½ | 177.44 | 7.084 |
| 1½ | 209.42 | 13.960 | 16 | 175.87 | 6.838 |
| 2 | 208.54 | 13.715 | 16½ | 174.26 | 6.592 |
| 2½ | 207.64 | 13.469 | 17 | 172.59 | 6.347 |
| 3 | 206.73 | 13.223 | 17½ | 170.86 | 6.101 |
| 3½ | 205.80 | 12.978 | 18 | 169.07 | 5.856 |
| 4 | 204.86 | 12.732 | 18½ | 167.23 | 5.610 |
| 4½ | 203.91 | 12.487 | 19 | 165.31 | 5.364 |
| 5 | 202.94 | 12.241 | 19½ | 163.32 | 5.119 |
| 5½ | 201.95 | 11.995 | 20 | 161.25 | 4.873 |
| 6 | 200.95 | 11.750 | 20½ | 159.09 | 4.628 |
| 6½ | 199.93 | 11.504 | 21 | 156.83 | 4.382 |
| 7 | 198.89 | 11.259 | 21½ | 154.46 | 4.136 |
| 7½ | 197.83 | 11.013 | 22 | 151.97 | 3.891 |
| 8 | 196.75 | 11.767 | 22½ | 149.34 | 3.755 |
| 8½ | 195.65 | 10.522 | 23 | 146.55 | 3.410 |
| 9 | 194.53 | 10.276 | 23½ | 143.59 | 3.164 |
| 9½ | 193.39 | 10.031 | 24 | 140.42 | 2.918 |
| 10 | 192.23 | 9.785 | 24½ | 137.01 | 2.673 |
| 10½ | 191.03 | 9.359 | 25 | 133.32 | 2.427 |
| 11 | 189.81 | 9.294 | 25½ | 129.31 | 2.172 |
| 11½ | 188.57 | 9.048 | 26 | 124.89 | 1.526 |
| 12 | 187.30 | 8.803 | 26½ | 119.94 | 1.680 |
| 12½ | 186.00 | 8.567 | 27 | 114.34 | 1.435 |
| 13 | 184.66 | 8.311 | 27½ | 107.84 | 1.189 |
| 13½ | 183.29 | 8.066 | 28 | 100.05 | 0.944 |
| 14 | 181.88 | 7.820 | 28½ | 90.24 | 0.698 |
| 14½ | 180.44 | 7.575 | 29 | 76.80 | 0.453 |
| 15 | 178.96 | 7.329 | 29½ | 54.21 | 0.207 |

On the assumption that the degree of heat to which tobacco could be subjected without injury is much greater than that required to boil water, it was believed that lowering the boiling point, by means of a vacuum, below that obtaining under ordinary atmospheric conditions would cause a distention of the cellular tissues of the insect to such an extent as to destroy all life. Thus water, which at sea level boils at 212° F., at a 28-inch vacuum boils at 101° F. So if the temperature of the body mass of the insect can be raised above the corresponding boiling point, which would be 101° in a 28-inch vacuum, for every degree over that point which the temperature is raised just so much more violent will be the internal disturbance created in the body of the insect.

In actual practice, the steam coil in this machine is capable of raising the temperature of the air to 160°, a point more than high enough to kill any beetle. This does not mean, however, that the heat of the entire mass will reach this degree when the chamber is filled with boxed cigars, as the interior of some of the center boxes will not reach over 110° to 118°.

In actual practice, the following shows an average daily and weekly output:

| Time. | Temperature. | Contents. | |
|---|---|---|---|
| *a. m.* | ° | | |
| 8.10 | 120 | | |
| 9.10 | 148 | Londres | 33,000 |
| 10.10 | 154 | P. Wash | 1,500 |
| 10.40 | 154 | | |
| 11.02 | 142 | Total | 34,500 |
| 11.10 | 136 | | |
| 11.50 [a] | 140 | | |
| | | Londres | 33,000 |
| *p. m.* | | P. Wash | 1,500 |
| 12.50 | 152 | | |
| 2.05 | 157 | Total | 34,500 |
| 2.30 | 146 | | |
| 2.50 | 126 | | |
| 3.00 | 128 | Londres | 33,000 |
| 4.00 | 153 | P. Wash | 1,500 |
| 5.00 | 154 | | |
| 6.00 | 158 | Total | 34,500 |
| 6.25 | 143 | | |

Cigars processed during the week ending August 30, 1916:

*August 25.*

| | |
|---|---|
| Londres | 30,900 |
| R. Victoria | 30,000 |
| Londres | 30,000 |
| Total | 90,900 |

*August 26.*

| | |
|---|---|
| Londres | 33,000 |
| Exquisitos | 8,750 |
| P. Wash | 4,900 |
| Lon. de 50 | 1,800 |
| Lon. de 12 | 13,000 |
| Havanas | 2,000 |
| Londres | 24,000 |
| Conchas | 5,000 |
| Princesas | 5,000 |
| Total | 97,450 |

*August 27.*

| | |
|---|---|
| P. Wash | 3,625 |
| Hav. extra | 2,500 |
| Lon. Sueltos | 18,000 |
| Do | 10,000 |
| Do | 30,000 |
| P. Wash | 1,700 |
| Exquisitos | 6,800 |
| P. Wash | 1,525 |
| Londres | 20,000 |
| Total | 94,150 |

*August 28.*

| | |
|---|---|
| Londres | 33,000 |
| P. Wash | 1,500 |
| Londres | 33,000 |
| P. Wash | 1,500 |
| Londres | 33,000 |
| P. Wash | 1,500 |
| Total | 103,500 |

*August 29.*

| | |
|---|---|
| Lon. sueltos | 34,000 |
| Do | 32,000 |
| Do | 34,000 |
| Total | 100,000 |

*August 30.*

| | |
|---|---|
| Londres | 24,000 |
| Conchas | 5,000 |
| Princesas | 5,000 |
| Londres | 22,000 |
| Bribita | 3,400 |
| Exquisitos | 3,600 |
| Havanas | 1,500 |
| Do | 1,600 |
| P. Wash | 2,275 |
| Londres | 33,000 |
| Total | 101,375 |

This machine has been working virtually every day for over 300 days since it was installed and over 25,000,000 cigars have been processed. Statements have been made to the writer by the manager of this factory that he is satisfied that this process will kill the beetle in all stages, basing his opinion on the fact that no complaints regarding worms have ever been received from cigars that have been processed. Though this process is essentially adapted for finished cigars ready for packing, it can be utilized successfully to treat loose filler tobacco. It cannot be used with baled tobacco for the reason that the heat will not penetrate baled tobacco more than 2 inches.

The machine is most simple, requiring only five operations: Closing door, awaiting desired rise in temperature, starting pump, stopping pump, opening valves and removing product. The application of this method is naturally limited to such factories as are equipped with boilers.

It will perhaps be stated that the air temperature attained within the chamber is sufficient to kill insects in all stages without the necessity of vacuum. While this is true, this degree of heat does not prevail throughout the mass, that of the center being much lower. By the thermometer reading it is possible to judge by experience what the heat of the mass will be, as practice has shown that with the machine in question, one hour after the thermometer registers 154° the mass will be heated according to its proximity to the heater from 150° to 110° or 118° according to the way the product is stacked.

For experimental purposes an ordinary vacuum fumigator was equipped with a steam coil. The manager of the factory in which it is operating seems to believe that it meets all requirements. The fact that it has been operating under factory conditions for 300 days and shows a daily average of 100,000 cigars per day of 10 hours, demonstrates its commercial practicability; also, its ability to handle, if operated overtime, the output of almost any factory in the city of Manila.

In commenting upon the former of the two methods of treatment, it will immediately be said that carbon bisulphide is likely to damage cigars that are subjected to its fumes. The best answer to such a statement is furnished by the fact that several factories in Manila are using and have been using this compound for the past four years, treating virtually their entire output. Each of these factories applies it both under vacuum and by simple evaporation.

The statement to the writer of the sales manager of one of the largest distributing houses for Manila in the United States

covers this question in its entirety. "The dealers and factory people of the United States are fully cognizant of the benefits to be derived from the use of carbon bisulphide and the sooner the manufacturers in the Philippines realize its benefits the better it will for their business." From Sumatra comes another similar statement to the effect that until carbon bisulphide was used the losses incurred from beetles were such as to threaten bankruptcy and since its adoption no further losses have occurred.

Assuming that it has been proved that the beetle can be killed in all stages by vacuum fumigation and that this process is not injurious to the tobacco, the problem before the tobacco men is how to organize control measures.

In studying the course of the tobacco from the time it is harvested, investigations show that baled tobacco is generally held at periods varying from two to six years before it is manufactured. The beetle enters the tobacco as soon as it has become dried and is baled with it. This gives it a chance to breed uninterrupted through, say six generations, or three years. If each beetle lays 30 eggs, and there are six months to a generation and if only 10 per cent of the progeny in each generation survived and procreated, this would allow the progeny of a single pair of beetles to multiply as follows:

| | | | |
|---|---|---|---|
| First generation | 3 | Fifth generation | 243 |
| Second generation | 9 | Sixth generation | 729 |
| Third generation | 27 | Seventh generation | 2,287 |
| Fourth generation | 81 | Eighth generation | 8,851 |

The above figures allow for a normal estimate in accordance with the increase of insects. In a state of nature about 90 per cent of the progeny of all insects are killed off through natural influences and a species thus checked is not generally injuriously abundant.

It is an acknowledged fact that a great amount of damage is done to baled tobacco by this species. Philippine tobacco is baled in a rather haphazard manner being covered with only plaited stems of the banana plant. The baling process could be greatly improved by sewing up the bale in good strong cotton cloth. Beetles do not like to walk on cotton as their feet catch in the nap and this makes locomotion difficult. It has been shown that the beetle prefers the lighter and finer grades and that in these grades the heaviest losses occur.

According to Bureau of Agriculture statistics there were produced in 1916 in the Provinces of Cagayan and Isabela, respectively, 6,830,561 kilos and 15,757,178 kilos, a total of 22,587,739

kilos. As each bale contains 150 kilos, this would make 150,585 bales.

Six vacuum fumigators with capacities of 20 bales each, allowing three hours for each operation, would treat from 900 to 960 bales every twenty-four hours, or would take approximately 156 days to treat the entire crop. The number of fumigators is placed at three "in battery" in order to allow for the more economic use of $CS_2$ and of labor.

Internal revenue regulations prohibit the use of any tobacco for export or wrapper purposes that is not grown either in Cagayan or Isabela Provinces. Virtually all tobacco from these provinces comes to Manila through the port of Aparri in Cagayan. Most of the crop is shipped within six months after it is harvested.

By subjecting tobacco to one such treatment in addition to sacking, it is estimated that the losses from beetles would be reduced by 90 per cent and the damage would be confined to the surface of the bale. Any project of this nature would necessarily have to be conducted by the Government.

Another method of controlling beetles is what it known as the *X*-ray process. While factory managers, it seems, often alluded to it, nothing appears to be known by them in the matter, except that such a process exists.

In order that those interested in this method may obtain a more complete idea of its possibilities, the writer has investigated it, especially with a view to its adaptability to the local conditions as prevailing in Manila.

This process is a very ingenious application of the X-ray and offers what would theoretically be an ideal method of controlling this pest. According to information furnished by the makers of the machines, they are of two types: First, the old conveyor type that carried the finished boxed products through a tunnel during which they were exposed to the rays. The second is on a larger scale and is called the "humidor" type. It is installed in the humidor of the factory and operated by the foreman and is of sufficient size to be adaptable to bale use.

One of these machines, in actual use at Tampa, Florida, is equipped with 18 X-ray tubes. These cost about $100 each. The makers state that if they can get 1,000 hours per tube the machine is feasible, if not, the cost of the tubes would make it prohibitive for factories that have only a slight loss annually from the beetles. It is impossible to determine beforehand the life of a tube.

A machine of the humidor type will have, in actual factory

practice, a capacity of 60,000 cigars every 42 minutes. The cost of installation depends upon the number of cigars to be treated. As the war has enhanced the value of everything entering into the make up of these machines, they are, of course, very expensive to construct under present conditions. Assuming that the manufacturer will line his humidor with lead, a machine can be installed in a factory making about 50,000 cigars a day for from $3,000 to $3,500.

The makers of these machines require a royalty for every thousand cigars processed, the cost being shown in the following excerpt from one of their specimens of contract for the conveyor type of machine:

> The machine duly equipped shall be installed by the parties of the first part (makers) who agree to keep the said machine in repair and proper operating condition. The cost of operation of the machine shall be paid by the parties of the second part who will cause to pass through the said machine and be treated by said process each and every cigar manufactured in said factory on which revenue stamps are placed. Party of the second part agrees to pay a royalty to the party of the first part for the use of said machine in treating cigars manufactured by party of the second part by said process, as follows:
>
> For 5,000,000 cigars per annum, not less than 30 cents per thousand cigars.
>
> For 5,000,000 to 10,000,000 cigars per annum, 25 cents per thousand cigars.
>
> For 10,000,000 to 15,000,000 cigars per annum, 20 cents per thousand cigars.
>
> For 15,000,000 to 20,000,000 cigars per annum, 17½ cents per thousand cigars.
>
> For 20,000,000 to 30,000,000 cigars per annum, 15 cents per thousand cigars.
>
> For 30,000,000 cigars per annum and over, 12½ cents per thousand cigars.
>
> The party of the second part further covenants and agrees to pass through said machine nothing but finished cigars in tight boxes and license to use said machine does not cover the use of the machine for other purposes of any nature or kind.
>
> Contracts are for a period of five years. Six months shall be allowed to demonstrate the efficiency of the machine. If the machine fails to sterlize the eggs of the cigarette beetle and prevent insect damage to the cigars when same have been properly treated, the said party of the first part will remove the same and the contract will be cancelled. It is distinctly understood and agreed between the parties hereto that in no case shall the price for use of the said machine be less than $1,500 per annum.

Such, in brief, are some of the contract stipulations that may be of interest to manufacturers. Reviewing these excerpts, it will readily be seen that the contract contains many clauses which would not be acceptable to local manufacturers. That clause which compels manufacturers to treat each and every cigar

manufactured would particularly militate against its acceptance for the following reasons: Most of the Manila factories produce a large number of cigars that are sold for consumption on the local markets at a very low price, and, naturally, the price of treatment of such cigars would be prohibitive; again, a large percentage of the cigars exported to the United States have, until the present year, been a very low-priced article, as shown by the average for 1916, $14.50 per thousand, and we thus have an increase in overhead charges in royalties alone of from 2 to 4 per cent, not including the cost of operating the machine.

Apparatus of this kind would be feasibly operated for the treatment of export cigars only by some Government agency. This in its turn, would involve added expense of transportation, handling and operation, which would increase the costs of production to such an extent that its use, under manufacturing conditions, such as are prevailing in Manila, would be prohibitive.

While the cost of operation has not been given, it is estimated that this would be in the neighborhood of $6 per hour, based on the following:

The X-ray tubes are operating at 45,000 volts and a current of 100 millamperes is passed through them. At this rate there would be consumed about 40 kilowatts per hour and with the prevailing rate of current at 15 cents per kilowatt, the above figure would be obtained. However, to this would have to be added the resultant losses in efficiency between motor and generator which would perhaps represent another 5 per cent. At this figure the costs of operation are comparatively moderate. The method offers a process which would meet the demands of the most fastidious, with the exception of the contract.

### MOLD.

With almost periodic regularity, complaints have been received that shipments of Manila cigars when opened in the United States are found to be moldy. Aside from the damage done to the reputation of the Manila cigars, this makes for a considerable added expense, as all moldy cigars must be reconditioned by wiping off the mold growth by hand, a process which costs $0.30 per thousand cigars.

A fair idea of the importance of mold trouble can best be realized when it is understood that since April 14, 1916, 777,000 Manila cigars have been reconditioned because of mold, at a cost of $233.

A study of this problem demonstrates that cigars packed during the rainy season were most likely to develop mold. The

growth is generally heaviest at the closed end, where the paste is thickest.

Investigation of the processes involved in the manufacture of cigars in those factories against which complaints have been received, shows that a number of manufacturers use a paste made from sago flour, which is almost entirely starch. It has also been observed that cigar makers, as a routine practice, smear the paste all over the inner surface of the wrapper, the damp leaf being spread and smoothed down on a cutting board, which is liberally moistened with water. This board is constantly damp and from time to time receives particles of paste, the same vessel which furnishes the water being used to wash off excess paste from the finger used in applying it, and in so far as the application of paste to the wrapper is concerned mold may be expected on practically any portion of the wrapper, as a natural consequence of the methods employed.

R. H. True, in an interesting paper entitled "The Molds of Cigars and Their Prevention,"[2] has shown four molds to be present on cigars, the most common of which is *Aspergillus candidus,* a species which has been identified by Dr. Yates, mycologist of the Bureau of Science, from specimens furnished by the writer, as the one which is the cause of complaint against the Manila cigars.

In his work, True has shown that this species and *Penicillim glaucum* also, which together are the most prevalent molds found on cigars, will not grow on the wrapper leaves in the absence of some other substance, foreign to the leaf, which might act as a source of food for the fungi. He has also made repeated attempts to grow the organism in question on pieces of cigars placed in sterile test tubes. In this connection, he states that the pieces from the head of a cigar could be made to mold without difficulty while other parts molded less rapidly.

The results of these experiments confirm the view that those molds which are the causes of most of the trouble are introduced and in general grow on the paste and that the appearance of mold over a large part of the surface of the cigars indicates the smearing of excess paste over a corresponding portion of the surface.

As heat and moisture are necessary conditions for mold development in the Tropics, where heat with a high relative humidity is found, mold is to be expected. Since mold is likely to appear whenever heat and moisture combine to form a favorable condition for its growth or follow the exposure of the cigar

[2] Bulletin No. 109, U. S. Department of Agriculture.

to the infecting organism, any disinfectant to be an effective agency must be permanent.

In reporting on the possible disinfectants available for use as paste, the writer has tried a number, including formaldehyde, salycylic acid, and boric acid. Under factory conditions, such as those prevailing in Manila, the formula given by True has been found most practicable. "Place boric acid at the rate of 3.8 parts per hundred parts of water and stir until the acid is all dissolved. Use this solution instead of water in making up the paste. Great care should be taken not to use more paste than is necessary, as it is liable to be smeared over the surface of the cigars."

Much good could be accomplished if the use of paste in which starch is the basic compound could be entirely eliminated. A good gum-tragacanth, embodies all the advantages of a starch paste and only a few of the disadvantages. While it is susceptible to mold growth the danger from this source compared with sago paste is infinitesimal. One manufacturer who utilizes No. 1 gum-tragacanth, states that 1 pound of this gum is sufficient to furnish paste for 80,000 cigars, even present war prices not rendering its use prohibitive.

## DRYING ROOMS.

A further study of the problem of mold control shows that at the time complaints were being received of cigars being moldy, in most cases a proper check was not kept on drying operations.

In considering the problem of any drying rooms there are certain basic principles which must be considered. The records of the Philippine Weather Bureau show that the maximum humidity of the atmosphere reaches in the rainy season as high as 97 per cent, thus making it necessary for artificial heat to be utilized before proper drying can be accomplished.

*Table showing maximum humidities at Manila.*

[Fahrenheit.]

| Year. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1913 | 95.6 | 90.9 | 87.3 | 85.2 | 90.7 | 93.8 | 95.9 | 96.2 | 95.4 | 94.9 | 94.1 | 92.8 |
| 1914 | 91.5 | 91.2 | 87.4 | 87.9 | 89.6 | 94.2 | 95 | 92.8 | 95.8 | 92.4 | 92.5 | 95.2 |
| 1915 | 94.4 | 90.4 | 91.4 | 90.6 | 93.7 | 94 | 96.9 | 97.7 | 97 | 95.9 | 96.5 | 94.4 |

The evaporation of moisture depends on temperature. The more direct the application and the more intense the heat the more rapid will be the evaporation. The factor which governs the heat to be applied is, however, one which must be carefully

considered in every case. That is, the nature of the material itself as regards heat transmission. It invariably requires a given quantity of heat units to vaporize a given weight of water at any particular temperature regardless of the material of which the container is composed or of the time factor.

As only tobacco in the form of cigars as made in Manila is being dealt with, the product carries a variable water content, according to the shape, averaging 10 per cent of the weight.

The conditions under which Manila cigars are manufactured and the long period which must elapse before they are consumed makes proper drying one of the primary essentials to enable them to arrive in good condition. Broadly speaking, it is the one feature of manufacture that should be given first consideration, which is not always the case.

In taking up this problem, there are certain fundamentals that the manufacturer should know. These involve the amount of vapor a given quantity of air can carry; how to determine the percentage of vapor that the air in the drying room is carrying away; the relative humidity of the atmosphere; the heat losses through remediable agencies; the time required to dry the product; and the best method of applying the heat when necessary.

As a given volume of air can carry only a given quantity of vapor at any given temperature, the importance of prompt removal is obvious, the capacity of the air varying with the temperature. Evaporation of water goes on at all temperatures and pressures, forming aqueous vapor. This vapor has some striking and important properties different from air which are conspicuous in drying processes. The most noticeable is the increase in volume that takes place at the instant it changes from water to vapor when it suddenly increases its volume 1,700 times. The quantity of vapor in the atmosphere is measured by hygrometers. The wet and dry bulb is the most common and can readily be made on the spot by means of two ordinary thermometers (fig. 12). One thermometer (dry) registers as usual, the bulb of the other being kept wet by means of a piece of linen in a glass of water. By noting the two temperature records, the degree of humidity can be readily found (see next table).

If the dry bulb records 90° F., and the wet bulb records 80° F., then reading under the 10° difference on the 90° line, it seems that the air is 65 per cent saturated or contains 65 out of all possible humidity it is capable of absorbing at 90°.

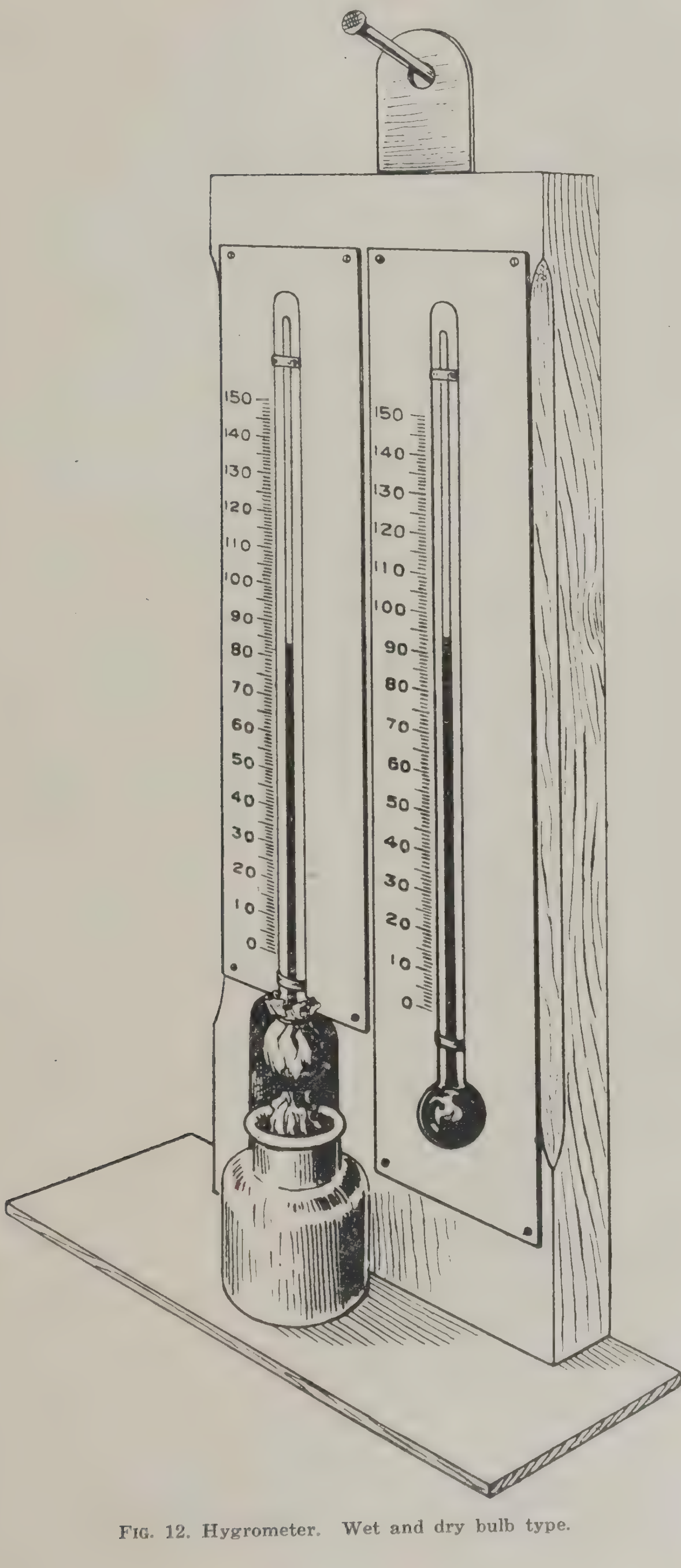



FIG. 12. Hygrometer. Wet and dry bulb type.

*Relative humidity, per cent.*[a]

[Relative humidity, saturation being 100. (Barometer=30 ins.)]

| Dry thermometer, (°F.). | Difference between the dry and wet thermometers, (°F.). | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 26 | 28 | 30 |
| 32 | 89 | 79 | 69 | 59 | 49 | 39 | 30 | 20 | 11 | 2 | | | | | | | | | | | | | | | | | |
| 40 | 92 | 83 | 75 | 68 | 60 | 52 | 45 | 37 | 29 | 23 | 15 | 7 | 0 | | | | | | | | | | | | | | |
| 50 | 93 | 87 | 80 | 74 | 67 | 61 | 55 | 49 | 43 | 38 | 32 | 27 | 21 | 16 | 11 | 5 | 0 | | | | | | | | | | |
| 60 | 94 | 89 | 83 | 78 | 73 | 68 | 63 | 58 | 53 | 48 | 43 | 39 | 34 | 30 | 26 | 21 | 17 | 13 | 9 | 5 | 1 | | | | | | |
| 70 | 95 | 90 | 86 | 81 | 77 | 72 | 68 | 64 | 59 | 55 | 51 | 48 | 44 | 40 | 36 | 33 | 29 | 25 | 22 | 19 | 15 | 12 | 9 | 6 | | | |
| 80 | 96 | 91 | 87 | 83 | 79 | 75 | 72 | 68 | 64 | 61 | 57 | 54 | 50 | 47 | 44 | 41 | 38 | 35 | 32 | 29 | 26 | 23 | 20 | 18 | 12 | 7 | |
| 90 | 96 | 92 | 89 | 85 | 81 | 78 | 74 | 71 | 68 | 65 | 61 | 58 | 55 | 52 | 49 | 47 | 44 | 41 | 39 | 36 | 34 | 31 | 29 | 26 | 22 | 17 | 13 |
| 100 | 96 | 93 | 89 | 86 | 83 | 80 | 77 | 73 | 70 | 68 | 65 | 62 | 59 | 56 | 54 | 51 | 49 | 46 | 44 | 41 | 39 | 37 | 35 | 33 | 28 | 24 | 21 |
| 110 | 97 | 93 | 90 | 87 | 84 | 81 | 78 | 75 | 73 | 70 | 67 | 65 | 62 | 60 | 57 | 55 | 52 | 50 | 48 | 46 | 44 | 42 | 40 | 38 | 34 | 30 | 26 |
| 120 | 97 | 94 | 91 | 88 | 85 | 82 | 80 | 77 | 74 | 72 | 69 | 67 | 65 | 62 | 60 | 58 | 55 | 53 | 51 | 49 | 47 | 45 | 43 | 41 | 38 | 34 | 31 |
| 140 | 97 | 95 | 92 | 89 | 87 | 84 | 82 | 79 | 77 | 75 | 73 | 70 | 68 | 66 | 64 | 62 | 60 | 58 | 56 | 54 | 53 | 51 | 49 | 47 | 44 | 41 | 38 |

[a] Condensed from the hygrometric tables of the U. S. Weather Bureau.

Since experience has shown that cigars must be dried very slowly and evenly to prevent injury, manufacturers have worked out this problem and dry their product generally on an average of from four to seven days.

Experience with a drying room artificially heated shows that 94° to 104° is hot enough for all purposes, in fact drying is too rapid at the above extreme of temperature.

The amount of heat which heaters can emit to air passing through them depends on: (1) The difference in temperature between the air and the heated surface; (2) the area of the exposed surface; (3) the velocity of the air current; (4) the material of the heated pipes; and (5) the diameter of the heated pipes. When the cold-air supply is lower, the efficiency of the same temperature in the heater is higher and hence helps to make up the deficiency and tends to equalize the resultant air. As heat has to be emitted from the surface, the greater the contact surface, the greater the amount of heat that will be emitted.

The greater the velocity of the air against the surface the more heat it absorbs from the heater, but the increased velocity decreases the efficiency of the fan and increases the power required to operate it; it is found that 20 feet per minute is about maximum efficiency for all.

The following table shows the distribution of heat and the resultant emission.

*Heat transmission of steam pipes, heated body of cast iron.*

[Units of heat, emitted or absorbed, per square foot per hour.]

| Mean temperature of heated body, pipe, etc. (°F.). | Temperature of air and walls. | Units of heat per square foot per hour. | | | | |
|---|---|---|---|---|---|---|
| | | Air quiet. | Air moving. | By radiation. | By radiation and contact combined. Air quiet. | By radiation and contact combined. Air moving. |
| | ° | | | | | |
| 210 | 70 | 130.49 | 217.48 | 139.96 | 270.49 | 357.48 |
| 220 | 70 | 142.20 | 237 | 155.27 | 297.47 | 392.27 |
| 230 | 70 | 153.95 | 256.58 | 169.56 | 323.51 | 426.14 |
| 240 | 70 | 165.90 | 279.83 | 184.58 | 350.48 | 464.41 |
| 250 | 70 | 178 | 296.66 | 200.18 | 378.18 | 496.84 |
| 260 | 70 | 189.90 | 216.50 | 214.36 | 404.26 | 530.86 |
| 270 | 70 | 202.70 | 337.83 | 233.42 | 436.12 | 571.25 |
| 280 | 70 | 215.30 | 358.85 | 251.21 | 466.51 | 610.06 |
| 290 | 70 | 228.85 | 380.91 | 267.73 | 496.28 | 648.64 |
| 300 | 70 | 240.85 | 401.41 | 279.12 | 519.97 | 680.53 |

*Radiation power.*—The radiation power of the sections of any heater is also dependent on the material of which they are constructed. It has been found by actual experiment that the

number of heat units per hour per 1° F., difference of temperature, varies as follows:

| | |
|---|---|
| Copper | 0.0327 |
| Sheet iron | .092 |
| Cast iron (new) | .648 |
| Cast iron (rusty) | .6868 |
| Tin | .0439 |
| Glass | .5948 |

*Diameter.*—The size of the pipe, of course, affects the surface per foot run but it is found that the efficiency is much greater in small pipes. The following figures represent the actual British thermic units emitted under the specific condition, the air being 60° F., and the steam supply at 212° F. also gives a comparative guide for the different-sized pipes:

| | B. t. u. |
|---|---|
| 1 to 2-inch pipes | 350 |
| 2-inch pipes | 327 |
| 3-inch pipes | 303 |
| 4-inch pipes | 291 |
| 6-inch pipes | 279 |

The above shows that the smaller pipes have a considerable higher surface area of efficiency. For general purposes in calculating the radiation emission, it may be taken that it varies from 1.4 to 1.8 British thermic units per square foot of available surface per hour for each degree of difference between the temperature of the incoming air and the heater; for instance, with air at 82° and the steam in the heater at 220°, 220 minus 82 multiple 1.4=193.3 British thermic units per square foot per hour, according to the material of which the heater is constructed.

Examining the table covering the equalization of pipe diameters, it is seen that one 3-inch pipe can carry sixteen 1-inch pipes, which, with their increased powers of radiation, will increase the efficiency of the drier even allowing 75 per cent for loss in transmission—over 100 per cent. In general practice, to evaporate 3 pounds of air for every pound of coal is conceded to be relatively high efficiency.

*Equalization of pipe diameters.*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | | | | | | | | | | | | | | |
| 2 | 5.7 | 2 | | | | | | | | | | | | | |
| 3 | 16 | 2.7 | 3 | | | | | | | | | | | | |
| 4 | 32 | 5.7 | 2.3 | 4 | | | | | | | | | | | |
| 5 | 56 | 9.7 | 3.6 | 1.8 | 5 | | | | | | | | | | |
| 6 | 88 | 16 | 5.7 | 2.8 | 1.6 | 6 | | | | | | | | | |
| 7 | 129 | 23 | 8.3 | 4.1 | 2.3 | 1.5 | 7 | | | | | | | | |
| 8 | 180 | 32 | 12 | 5.7 | 3.2 | 2.1 | 1.4 | 8 | | | | | | | |
| 9 | 244 | 42 | 16 | 7.6 | 4.3 | 2.8 | 1.9 | 1.3 | 9 | | | | | | |
| 10 | 317 | 56 | 20 | 9.9 | 5.7 | 3.6 | 2.4 | 1.7 | 1.3 | 10 | | | | | |
| 11 | 402 | 71 | 26 | 12 | 7 | 4.5 | 3.1 | 2.2 | 1.7 | 1.3 | 11 | | | | |
| 12 | 501 | 88 | 32 | 16 | 9 | 5.7 | 3.8 | 2.8 | 2 | 1.6 | 1.2 | 12 | | | |
| 13 | 613 | 107 | 39 | 19 | 11 | 6.9 | 4.7 | 3.4 | 2.5 | 1.9 | 1.5 | 1.2 | 13 | | |
| 14 | 737 | 129 | 47 | 23 | 13 | 8.3 | 5.7 | 4.1 | 3 | 2.3 | 1.8 | 1.5 | 1.2 | 14 | |
| 15 | 876 | 152 | 56 | 27 | 16 | 9.9 | 6.7 | 4.8 | 3.6 | 2.8 | 2.2 | 1.8 | 1.4 | 1.2 | 15 |

In actual factory conditions in Manila a drying room 40 by 30 by 10 beet can be heated by a double line of 2½-inch pipes running around the room or having 280 running feet of superficial surface. These pipes will heat such a room to 107° or raise the temperature 25°, assuming the outside temperature to be 82° F., which is a fair average of the Manila temperatures.

In considering the problem of drying rooms, as applied to Philippine conditions, one is confronted with the fact that all factories are not equipped with boilers, and thus some other source of conveying heat must be looked for.

The same rules hold good regarding the amount of heat generated, whether steam, coal, gas, or any other agency is used.

The problem evolves itself into one of securing the most economical kind of heater. In tobacco drying, fuel gases are objectionable. A large percentage of heat is always wasted in carrying off these gases. Heaters employing illuminating gas offer many natural advantages. They can be installed in the drying rooms and the fuel gases can be allowed to intermingle with the air of the room to a certain extent dependent upon whether or not workers must be present therein. Economy with this type of heater will be subject to the same rules as refer to any other kind of heater. When utilizing this type, where fuel gases intermingle with the atmosphere, it becomes necessary to provide for good ventilation in order to allow the presence of labor and handling of tobacco, otherwise the combination of gases arising from the damp tobacco will render it difficult for laborers to work in the room for any time without great discomfort. This will apply more particularly to filler tobacco that has been washed and is being dried, than to cigars, especially as it becomes necessary in this process to have the workers in the room to watch and turn the tobacco at regular intervals.

At present, little has been done with gas heaters to attain the best results. Any drying room where a gas heater is used should have a fan to keep the air in circulation. This is necessary for two reasons: It increases the drying capacity of the room and does not allow the atmosphere to become heavily charged with the gas raising from the material, and with the fuel gases, which contain carbon dioxide, $CO_2$, and carbon monoxide, CO, the latter of which is much more poisonous than the former, and dangerous to inhale.

The heater shown in figures 13, 14 and 15 gives a maximum of heat for the amount of fuel consumed. Such a heater equipped for gas consumption with burners arranged in tubular form and aggregating 160 lineal inches of actual burner space, should,

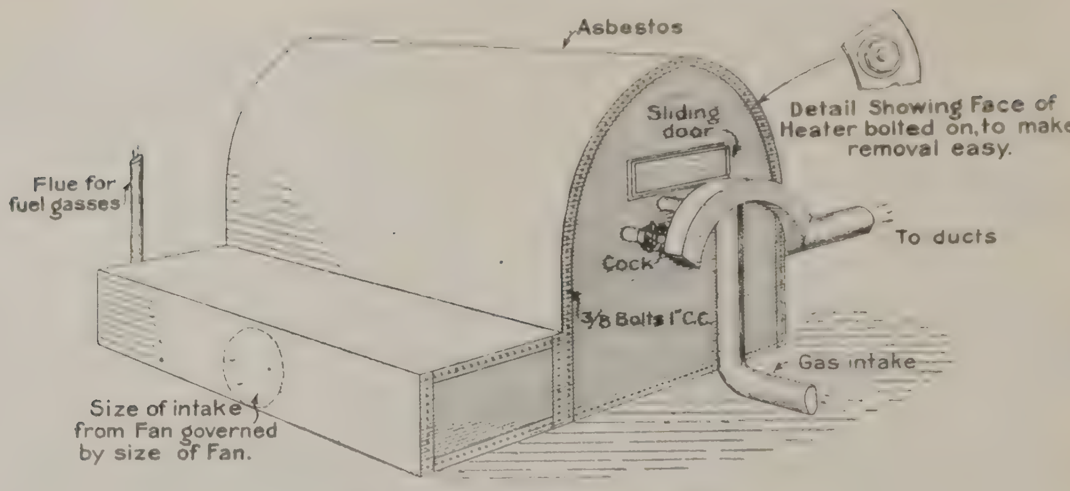



FIG. 13. Gas-furnace hot-air heater.

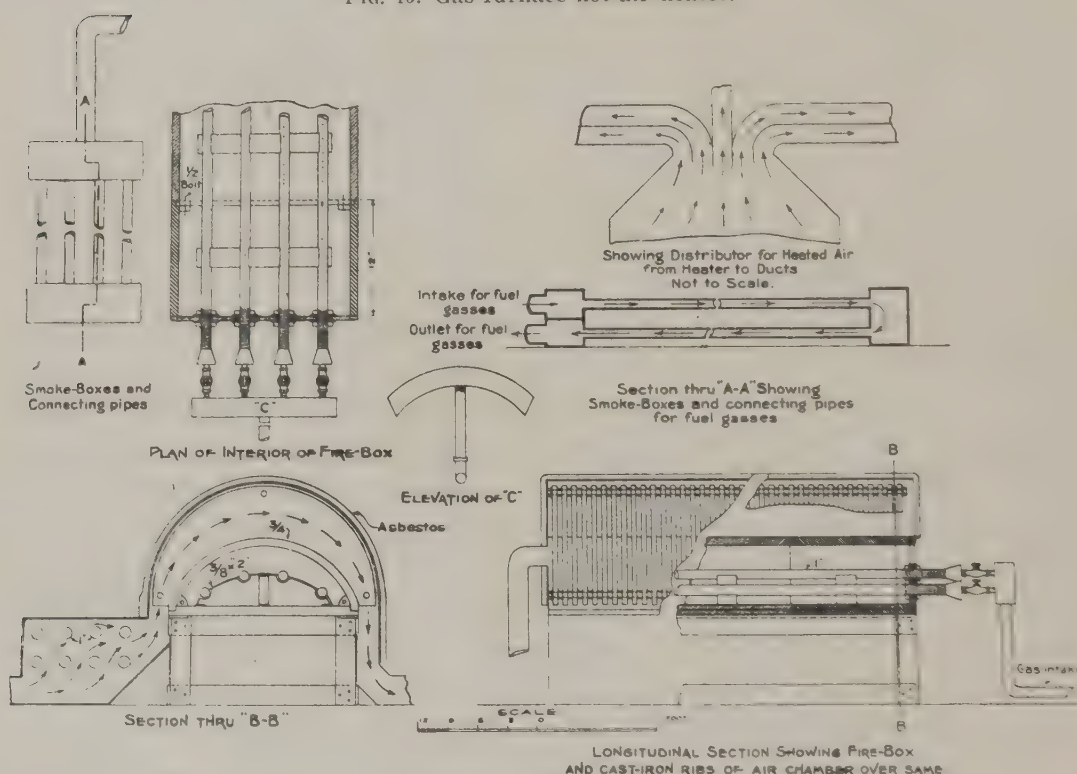



FIG. 14. Details of gas-furnace hot-air heater for plenum system.

if inclosed, and with an air current from a blower-fan passing over the heater, raise the temperature of this air to 122°, and maintain a temperature of 96° in a room having a capacity of 12,000 cubic feet. This temperature could be raised or lowered according to the amount of time the blower fan is operated and the size of the fan employed. All reliable makes of blowers give the following: Pressure in ounces per square inch of duct; velocity of air escaping per second or minute; and volume discharged in one minute through effective area in cubic feet.

The efficiency of such a heater will be greatly enhanced by a proper distribution of the air through ducts to different parts

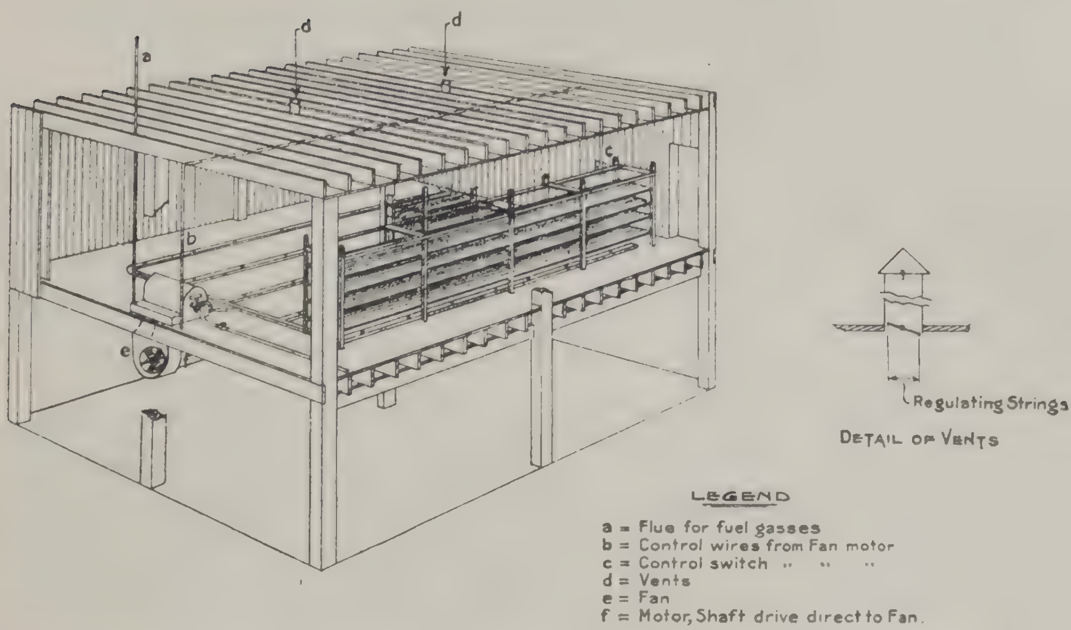



FIG. 15. Plan of drying room showing plenum system installed heater for gas consumption.

of the room. The location of these can be arranged to suit the shape of the room. In placing air ducts, it should be remembered that sharp angles tend to greater loss in heat transmission, while blind ends should always be avoided. All ducts should be well insulated, preferably with asbestos.

The proper position of outlets for escaping air is a matter which is often vexing. Generally speaking, where the weight of the material is great as compared with the moisture to be evaporated, heating of the material becomes an important factor. With tobacco, this will necessarily be done by radiation and from below, while outlets at the top will be found most convenient.

The above, in brief, summarizes the points which are essential and should be well understood by any one contemplating the construction or operation of an artificially heated drying room.

## CONCLUSIONS.

It should be remembered when reading the above description of processes for the control of beetles and mold that these processes are not the only means to control these pests. They simply constitute one means to this end, as a number of factories handle their product in such a manner that seldom, if ever, do they have trouble from these sources.

Since the beginning of the year 1911, the attention of this Bureau has been called to the losses arising from these sources, both by factories and officials of the Government. In all cases requests for assistance have been given immediate consideration.

Arrangements have also been made whereby the Government,

through the Bureau of Agriculture, keeps a stock of the fumigant $CS_2$ on hand and sells it to manufacturers at cost.

As a general rule the local factories have not cared to carry out the recommendations of this Bureau and have manifested but little interest in this matter. Other factories, which are engaged largely in the export trade to the United States and formerly suffered heavy losses from these sources, subject their entire product to these treatments as a routine practice and only in very rare instances have had any trouble whatever from either the beetles or the mold.

In connection with the problem of controlling the cigarette beetle and mold on cigars exported to the United States, it is believed that a feasible remedy for the trouble is available. It now depends entirely on the manufacturer whether or not he will allow his product to arrive on the United States market in a "wormy" or moldy condition.

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# NOTES ON CITRUS CANKER AFFECTION AT THE LAMAO EXPERIMENT STATION.

By P. J. WESTER, *Chief, Section of Horticulture.*

In the last number of this periodical an article by the writer contained a series of observations on the citrus canker infection of the citrus collection at the Lamao experiment station, observations which were made in January this year. In April another series of observations on the same trees was made by Mr. F. G. Galang, station superintendent, which is presented herewith. These observations should be read in conjunction with the article already published. Special attention is called to the behaviour of the immune or nearly immune varieties.

The observations on the canker affection will be continued and the results published in subsequent issues of this periodical.

*Table showing the degree of citrus canker affection in the citrus collection at the Lamao Experiment Station.*

| P. I. No.— | Botanical name. | Canker affection. | | | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | Serious. | Medium. | Slight. | Nearly immune. | Immune. | |
| 740 | *Citrus aurantium* | v | v | | | | |
| 923 | do | | | v | v | | |
| 966 | do | | v | | | | |
| 1728 | do | | v | v | | | |
| 1736 | do | | v | v | | | |
| 2340 | do | | | | | v | From the Mountain Province. |
| 2344 | do | | | v | | | |
| 2365 | do | | | | v | | |
| 2568 | do | v | v | | | | |
| 2569 | do | | v | v | | | |
| 2648 | do | | | v | | | |
| 2649 | do | | | v | | | |
| 3660 | do | | v | | | | |
| 3843 | do | | | | | v | Origin, Saigon, Indo-China. |
| 5699-1 | do | | | v | | | |
| 5522 | do | | | | | v | From the Mountain Province. |
| 706 | *Citrus aurantium,* "Bahia" | | v | v | | | |
| 1720 | do | | | | v | | |
| 2698 | *Citrus aurantium,* "Boone" | | v | v | | | |
| 4117 | *Citrus aurantium,* "Brown" | | | v | | | |
| 2695 | do | v | | v | | | |
| 4124 | *Citrus aurantium,* "Carleton." | v | | | | | |

*Table showing the degree of citrus canker affection in the citrus collection at the Lamao Experiment Station*—Continued.

| P. I. No.— | Botanical name. | Canker affection. | | | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | Serious. | Medium. | Slight. | Nearly immune. | Immune. | |
| 4119 | *Citrus aurantium*, "Dugat" | | v | | | | |
| 4120 | *Citrus aurantium*, "Duroi" | | | | v | | |
| 3886 | do | | | | v | | |
| 2698 | *Citrus aurantium*, "Enterprise." | | | v | | | |
| 2685 | *Citrus aurantium*, "Everbearing". | | | | | v | |
| 1260 | *Citrus aurantium*, "Excelsior." | | | v | v | | |
| 4126 | *Citrus aurantium*, "Foster" | | | v | | | |
| 1701 | *Citrus aurantium*, "Holdfast." | | | v | v | | |
| 2691 | *Citrus aurantinm*, "Homossassa." | | | v | | | |
| 1258 | *Citrus aurantium*, "Jaffa" | | | v | | | |
| 1719 | do | | | v | | | |
| 1637 | do | | | v | | | |
| 1722 | *Citrus aurantium*, "Joppa" | | | | v | | |
| 1714 | *Citrus aurantium*, "Larantta." | | | | v | | |
| 4123 | *Citrus aurantium*, "Magnum bonum." | | v | | | | |
| 1259 | *Citrus aurantium*, "Malta Blood." | | | v | | | |
| 2697 | do | | | v | | | |
| 2694 | *Citrus aurantium*, "Majorca" | | | v | v | | |
| 1743 | *Citrus aurantium*, "Mediterranean." | | v | v | | | |
| 1705 | do | | | v | v | | |
| 1277 | *Citrus aurantium*, "Seville" | | | | v | | |
| 1270 | *Citrus aurautium*, "St. Michael." | | | | v | | |
| 1742 | *Citrus aurantium*, "Navelencia." | | v | v | | | |
| 1635 | *Citrus aurantium*, "Pineapple." | | | v | | | |
| 2686 | do | | v | v | | | |
| 5177 | *Citrus aurantium*, "Pongkam." | v | | v | | | |
| 1917 | *Citrus aurantium*, "Ruby" | v | | v | | | |
| 1639 | do | | | v | | | |
| 1273 | *Citrus aurantium*, "Satsumanikan." | | | v | v | | |
| 2696 | *Citrus aurantium*, "Tardiff" | | | v | | | |
| 1706 | *Citrus aurantium*, "Valencia." | | | v | | | |
| 51 | do | | | v | | | |
| 1266 | *Citrus aurantium*, "Whitaker." | | | v | v | | |
| 1715 | *Citrus aurantium*, "White Siletta." | | v | v | | | |
| 1744 | *Citrus aurantium*, "Washington navel." | | v | v | | | |
| 2114 | do | | v | | | | |
| 1711 | do | | | v | | | |
| 1636 | do | | | v | | | |
| 549-1 | *Citrus decumana* | | | | | v | |
| 560-1 | do | v | v | | | | Very distinct type. |
| 741-3-4-6-7-13-17 | do | | v | v | | | |
| 742-1-2 | do | | | | v | | |
| 773-1-2-4 | do | | | v | | | |
| 750 | do | | | v | v | | |
| 891 | do | | | v | | | |
| 893 | do | | | v | | | Seedless varieties from Cabanatuan, Nueva Ecija. |
| 897-2-3 | do | | | v | | | Seedless pomelo from Cabanatuan, Nueva Ecija. |

*Table showing the degree of citrus canker affection in the citrus collection at the Lamao Experiment Station*—Continued.

| P. I. No.— | Botanical name. | Canker affection. | | | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | Serious. | Medium. | Slight. | Nearly immune. | Immune. | |
| 899 | do | | | | | v | |
| 969-2 | do | | | v | | | From Nueva Ecija. |
| 990-1-2-3 | do | v | | v | | | |
| 1448-1 | do | | | v | | | |
| 1646-2-4 | do | | | v | | | |
| 2257-1-2-3-4 | do | | | v | v | | |
| 2257-5-6 | do | | | v | v | | Very distinct type. |
| 2265 | do | | | | v | | |
| 2402 | do | | | v | | | |
| 2461-1-3-4-6-7 | do | | | v | | | |
| 2403 | do | | | v | v | | |
| 2503-2-3-4 | do | | v | | | | |
| 2503 | do | | | | v | | |
| 3035-1-2-3-4 | do | v | | v | | | |
| 3657 | do | | | | v | | |
| 3661 | do | | | | v | | Quality fair to good. |
| 3662 | do | | | | v | | Do. |
| 3673 | do | | v | | | | |
| 5523 | do | | v | | | | |
| 3384 | do | v | | | | | |
| 5181 | do | | | | | v | |
| 5188 | do | | | | | v | From Bulasan, Sorsogon. |
| 5699-6 | do | | | v | | | |
| 1995 | *Citrus decumana*, "Bankok" | | | v | v | | Seedless pomelo from Bangkok, Siam. |
| 1633 | *Citrus decumana*, "Case" | | | | v | | Said to be a pink-flesh pomelo of good quality. |
| 2687 | *Citrus decumana*, "Duncan" | v | | | | | |
| 1333 | *Citrus decumana*, "Ellen" | | v | | | | |
| 4868 | *Citrus decumana*, "Kellogg" | | | | v | | A variety from Nueva Ecija. Reported to be of exceptional quality. |
| 2690 | *Citrus decumana*, "Marsh" | v | | | | | |
| 1631 | do | | v | v | | | |
| 1707 | do | v | v | | | | |
| 3882 | *Citrus decumana*, "McCarty" | v | v | | | | |
| 2700 | do | | v | | | | |
| 4121 | do | v | | | | | |
| 3876 | *Citrus decumana*, "Nakoin" | | v | | | | Of Siamese origin. |
| 1334 | *Citrus decumana*, "Pernambuco." | | v | | | | |
| 5103 | *Citrus decumana*, "Panuban." | | | | | v | From Mountain Province. |
| 4125 | *Citrus decumana*, "Royal" | | | v | | | |
| 3389 | *Citrus decumana*, "Siam" | | | | v | | Siamese seedless pomelo. |
| 5152 | do | v | | | | | |
| 3442 | *Citrus decumana*, "Sinsemi" | v | v | | | | Do. |
| 1632 | *Citrus decumana*, "Triumh" | | | v | | | |
| 1713 | do | | | v | | | |
| 3391 | *Citrus decumana*, "Boyle" | | | v | | | A Siamese seedless. |
| 3392 | *Citrus decumana*, "Yugelar" | | | | | v | A Siamese seedless pomelo. |
| 4118 | *Citrus decumana*, "Walters" | v | | | | | |
| 5144 | *Citrus decumana*, "Lias" | | v | v | | | Panuban, variety Lias, from Mt. Prov. |
| 5146 | *Citrus decumana*, "Gaerlan" | | | | | v | Panuban, variety Gaerlan, from Bontoc, Mt. Prov. |
| 1618 | *Citrus decumana*, "Sampson" | | v | v | | | Tangelo; hybrid between pomelo & mandarin. |
| 1948 | do | | | v | | | Do. |
| 3385 | do | | | v | | | Do. |
| 741-5 | *Citrus excelsa* | | | v | | | |
| 741-8-12-21 | do | | | | v | | |

*Table showing the degree of citrus canker affection in the citrus collection at the Lamao Experiment Station*—Continued.

| P. I. No.— | Botanical name. | Canker affection. | | | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | Serious. | Medium. | Slight. | Nearly immune. | Immune. | |
| 741-16-18-19-20 | *Citrus excelsa* | | | | | v | |
| 833 | do | | | | v | | |
| 833-1-2-3-4 | do | | | v | v | | |
| 835 | do | | | | v | | |
| 853-1-2-3-5-6 | do | | | v | | | |
| 889-2 | do | | | v | | | |
| 1013-1-2-4 | do | | | v | v | | |
| 1727 | do | | | v | | | |
| 2655 | do | | | v | | | |
| 3388 | *Citrus* sp. near *excelsa* | | v | v | | | Of Saigon origin. |
| 3841 | do | | | v | | | Do. |
| 3888 | do | | | v | | | Do. |
| 3844 | do | | | v | | v | Do. |
| 970-1-2 | *C. excelsa* var. *davaoensis* | v | | | | | |
| 970-5-6 | do | v | v | | | | |
| 1009-2-3-4 | do | | v | | | | |
| 1257 | *Citrus japonica*, "Omikinkan." | | | v | v | | |
| 741-11 | *Citrus limetta* | | v | | | | |
| 741-15 | do | v | v | | | | |
| 818-1 | do | v | | | | | |
| 901-1-2-3-4 | do | v | v | | | | |
| 902 | do | | v | | | | A Philippine lime of superior quality. |
| 958 | do | v | | | | | Of Philippine origin, of excellent quality. |
| 5176 | do | | | v | v | | From Japan. |
| 1400-1-2-3-4 | do | v | | | | | |
| 1708 | *Citrus limetta*, "Tahiti" | | | | | v | From Australia. |
| 4122 | do | | | | | v | From Florida. |
| 4827 | do | v | | | | | |
| 2190-1-2-3-4 | do | v | | | | | |
| 5163 | do | | | | | v | From Hawaii. |
| 2346-15 | *Citrus* sp. near *limetta* | v | v | | | | Origin Hongkong. |
| 5184 | *Citrus limetta*, "Kusaie" | | | | | v | From Hawaii. |
| 3669 | *Citrus limetta*, "Everglade" | v | | | | | |
| 5182 | *Citrus limetta*, "Kusaie" | | | | | v | Do. |
| 3670 | *Citrus limetta*, "Trinidad" | | v | | | | |
| 2882 | *Citrus limetta*, "Pati China" | | | | | v | |
| 2346-9-10 | *Citrus limetta* var | | | | v | | Very distinct and interesting type. |
| 2346-5-7-8 | do | | | v | v | | |
| 3672-1-2-3-4 | do | v | v | | | | |
| 741-1-10-23-24-25 | *Citrus limetta* var. *aromatica* | | v | | | v | |
| 897-5-7 | do | | | v | | | |
| 975 | do | v | v | | | | |
| 1749 | do | | v | v | | | |
| 2498-2-3-4 | do | v | v | | | | |
| 2182 | do | | v | | | | |
| 2500-5-6 | do | v | v | | | | |
| 2500-1 | do | | | v | | | |
| 2532 | do | | v | v | | | |
| 4827 | do | | v | | | | |
| 691 | *Citrus limonum*, "Belair" | | | | v | | |
| 692 | *Citrus limonum*, "Villafranca." | | | | | v | From Australia. |
| 708 | *Citrus limonum*, "Lisbon" | | | | v | | |
| 1634 | *Citrus limonum*, "Valencia" | | | | v | | |
| 1642 | *Citrus limonum*, "Clarke" | | | | v | | |
| 1702 | *Citrus limonum*, "Villafranca." | | | | | v | Do. |
| 1703 | *Citrus limonum*, "Lisbon variegated." | | | | | v | Do. |
| 1704 | *Citrus limonum*, "Bengal" | | | | v | | |
| 1710 | *Citrus limonum*, "Sicily" | | | | | v | Do. |
| 4804 | *Citrus limonum*, "African" | | | | | v | Do. |
| 1712 | *Citrus limonum*, "Thornless" | | | | | v | Do. |
| 1723 | *Citrus limonum*, "Messina" | | | | v | | |

*Table showing the degree of citrus canker affection in the citrus collection at the Lamao Experiment Station*—Continued.

| P. I. No.— | Botanical name. | Canker affection. Serious. | Medium. | Slight. | Nearly immune. | Immune. | Remarks. |
|---|---|---|---|---|---|---|---|
| 3675 | *Citrus limonum* var. "Rough." | | | v | v | | |
| 875 | do | | | | v | | |
| 741-22 | *Citrus limonum* var | | | | v | | Very distinct form. |
| 959 | do | | v | v | | | |
| 3655 | *Citrus* sp. near *limonum* | v | | | | | |
| 5175 | *Citrus limonum* | | | | | v | From Japan. |
| 790-1-4-5-6 | *Citrus histrix* | | v | v | | | Very distinct type from Bataan. Fruit of remarkably good quality. |
| 790-2-3 | do | | v | | | v | |
| 807-1-2-3-4-5-6-7-8-9-10-11. | do | | v | v | | | |
| 834-1-2-3-4 | do | | | v | | | |
| 834-5-6-7-8 | do | | | | | v | Very distinct form. |
| 834-9-10 | do | | | v | | v | |
| 2570 | do | | | | | v | |
| 3665 | do | | | | v | | |
| 3668 | do | | | | | v | Very distinct type said to be of very good quality for ade. From Selners Hacienda, Abucay, Bataan. |
| 2494 | do | | v | | | | |
| 4214 | do | v | v | | | | |
| 4225 | do | | v | | | | |
| 4822 | do | | v | | | | |
| 4830 | do | | | v | | | |
| 5102-2-3-4-5 | do | v | v | | | | |
| 5102-1 | do | | v | | | | |
| 5165 | do | | | | | v | From Pampanga. |
| 5699-11 | do | | v | | | | |
| 2524 | *Citrus histrix* var. *boholensis* | | | | | v | |
| 3656 | do | | | v | | | |
| 4824 | do | | | v | | v | |
| 3673-1-2-3-4-5-6 7-8-9. | *Citrus histrix* var. *torosa* | v | v | | | | |
| 1982-1-2-3-4 | do | v | v | | | | |
| 2535 | do | v | | | | | |
| 5137 | do | | | v | | | |
| 5189 | do | | | v | | | |
| 27-3-4-12-15-16-17. | *Citrus medica* | | | | | v | |
| 790-7 | do | | | | v | | |
| 840 | do | | | v | | | |
| 1010 3-4 | do | | v | v | | | |
| 1278 | *Citrus medica*, "Finger" | | v | v | | | |
| 1716 | *Citrus medica*, "Common" | | | | v | | |
| 2652 | do | | | v | | | |
| 2499-1-2-3-4-5-8-9. | *Citrus medica* | | | v | v | | |
| 3836 | do | | | | v | | |
| 4739 | do | | | | | v | |
| 4826 | do | | | v | | | |
| 5699-5 | do | | | | v | | |
| 5699-8-9 | do | | | v | | | |
| 2264 | *Citrus* sp. near *medica* | | | | v | | |
| 2183 | do | | | v | | | |
| 1010-5-6-7 | do | | | v | | | |
| 848 | do | | | v | | | |
| 19-5-7 | *Citrus medica odorata* | | | | | v | |
| 19-6 | do | | | | | v | |
| 624-3 | do | | | | v | | |
| 809-2 | *Citrus medica nanus* | | | v | | | |
| 2384 | do | | | | v | | |
| 5699-4 | do | | | | v | | |
| 2372-7 | *Citrus macrophylla* | | | | v | | |

*Table showing the degree of citrus canker affection in the citrus collection at the Lamao Experiment Station*—Continued.

| P. I. No.— | Botanical name. | Canker affection. | | | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | Serious. | Medioum. | Slight. | Nearly immune. | Immune. | |
| 2372-1-2-3-4 | *Citrus macrophylla* | | | v | v | | |
| 4820 | do | | | v | | | |
| 741-9 | *Citrus mitis* | | | | | v | |
| 741-14 | do | | | | v | | |
| 772 | do | | | | | v | |
| 1718 | do | | | | | v | |
| 2184 | do | | | v | v | | |
| 2332 | do | | | | | v | |
| 2355 | do | | | | | v | |
| 2513 | do | | | | | v | Of excellent quality. |
| 2653-5 | do | | | | v | | |
| 2534 | do | | | | | v | Do. |
| 2346-6 | do | v | | | | | |
| 5699-2 | do | | | | | v | |
| 2502 | *Citrus micrantha* | | | v | | | |
| 2502-1-2 | do | | | v | | | |
| 1981 | do | | | | | v | |
| 5699 | do | | v | v | | | |
| 1982-1-2-3-4-5-6-7-8. | *Citrus* sp. near *micrantha* | v | | | | | |
| 4832 | *Citrus micrantha microcarpa.* | | | | v | | |
| 4821 | do | | | v | | | |
| 3659 | do | | v | v | | | |
| 2529-1-2-3-4-5 | *Citrus longispina* | | | v | | | |
| 2528-2-3-4-5-6-8-9-10. | do | | v | v | | | |
| 4838 | do | | | | | v | From Bohol. |
| 4839 | do | | | v | v | | |
| 4840 | do | | | | v | | |
| 3658 | do | | v | v | | | |
| 4833 | do | | | | | v | From Bohol. |
| 1647-1-2-3-4 | *Citrus nobilis* | | | | | v | From Manila. |
| 1913-1-2-3-4 | do | | | | v | | |
| 2346-1-2-3-4 | do | | | v | v | | |
| 2448-1-2-3-4 | do | | | | | v | From China. |
| 2448-5-6-7-8-9-10 11-12. | do | | | v | v | | |
| 2469-1-2-3-4-5 | do | | | v | v | | |
| 2527-1-2-3-4 | do | | | | v | | |
| 2527-5-6 | do | | | v | | | |
| 2528-1-3-7 | do | | | | | v | |
| 2650 | do | | | v | v | | |
| 2651-1-2-3-4 | do | | | | | v | |
| 2653 | do | | | | | v | |
| 4828 | do | | | | | v | |
| 1256 | *Citrus nobilis*, "Ladu" | | | | | v | |
| 1261 | *Citrus nobilis*, "mandarin" | | | | | v | |
| 1262 | *Citrus nobilis*, "Suntara" | | | | | v | |
| 1263 | *Citrus nobilis*, "Sikkim" | | | | v | | |
| 1265 | *Citrus nobilis*, "China" | | | v | | v | |
| 1267 | *Citrus nobilis*, "Szinkom" | | | | v | v | |
| 1271 | *Citrus nobilis*, "Kishiu" | | | | | v | |
| 1272 | *Citrus nobilis*, "Konda narun." | | | | | v | |
| 1275 | *Citrus nobilis*, "Unshiu" | | | | | v | |
| 1276 | *Citrus nobilis*, "Suntara Nagpur." | | | | | v | |
| 1335 | *Citrus nobilis*, "Oneco" | | | | | v | |
| 1918 | *Citrus nobilis*, "Dancy" | | | | | v | |
| 2693 | *Citrus nobilis*, "King" | | | v | | | |
| 3883 | do | | | | | v | |
| 5139 | *Citrus nobilis*, "Ubay" | | | | | v | |
| 5178 | do | | | | v | | |
| 5174 | do | | | | | v | |
| 5141 | do | | | | | v | |
| 5140 | do | | | | | v | |
| 5524 | do | | | | | v | |

*Table showing the degree of citrus canker affection in the citrus collection at the Lamao Experiment Station*—Continued.

| P. I. No.— | Botanical name. | Canker affection. | | | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | Serious | Medium. | Slight. | Nearly immune. | Immune. | |
| | *Citrus nobilis* | | | | | v | |
| 2984 | do | | | | | v | |
| 5142 | do | | | | | v | |
| 5173 | *Citrus nobilis* "var. *papillaris*." | | | v | v | | |
| 744 | | | | | | | |
| 745 | *Citrus nobilis* var. "Molana" | | | | v | v | |
| 5138 | *Citrus nobilis* var. "Malvar" | | | v | | v | |
| 5143 | *Citrus nobilis* var. "Rafael" | | | | v | | |
| 2346-12-13 | *Citrus nobilis* var | | | v | v | | Of Hongkong origin. |
| 2346-14 | *Citrus* sp. near *nobilis* | | | v | | | Of Hongkong origin with a very peculiar type with calamondin-like leaves and large apron. |
| 1953 | *Citrus pseudolimonum* | | v | | | | |
| 2496 | do | v | | | | | |
| 4226 | do | v | | | | | |
| 4836 | do | v | | v | | | |
| 2525-1-2-3-4-6-7-8. | *Citrus southwickii* | | | v | | | |
| 2517-1-2-3-4 | do | | | v | | | |
| 2526-1-2-3-4 | do | | | v | | | |
| 2049 | do | | | | v | | |
| 4841 | do | v | | | | | |
| 920-1-2 | *Citrus vulgaris* | | | | v | | |
| 969-1-2-3-4 | do | | | v | v | | |
| 969-5-6-7 | do | | | v | | | |
| 1011-2-1 | do | | | v | | | |
| 1011-3-4 | do | | | v | | | |
| 1264 | do | | | | v | v | |
| 1448-2-3-4 | do | | | v | | | |
| 1448-5-6 | do | | v | v | | | |
| 1453-1-2-3-5-6 | do | | | v | v | | |
| 1593-1-2-3-4 | do | | | v | | | |
| 1638 | do | | | | v | | |
| 2662 | do | | v | v | | | |
| 2357-1-2-3-4-5-6 | do | | | v | | | |
| 2385 | do | | | | v | | |
| 2511 | do | | | v | | | |
| 789-1-2-3-4-6-8-9 | *Citrus webberii* | | v | v | | | |
| 853 | do | | | v | v | | |
| 892-2-3-4 | do | | | v | | | |
| 892-5-6 | do | | | v | | | |
| 892-7 | do | | | v | | | |
| 896 | do | | | v | v | | |
| 897-9 | do | | | v | | | |
| 2066 | do | | | | | v | From the east coast of Mindanao. |
| 2275-1-2-3-4-6-7-8-9-10. | do | | v | v | | | Fruit decidedly oblate, very juicy and excellent for ade. |
| 2363-1-2-3-4 | do | | | v | v | | |
| 2363-5-6-7-8-9-10-11. | do | | | v | | | |
| 3671 | do | | | | v | | |
| 4828 | do | | | | v | | |
| 5102 | do | | | | | v | |
| 5104 | do | | | v | | | From Bontoc, said to be of unusually good quality. |
| 5105 | do | | | v | | | Do. |
| 5698-1-2-3-4-5-6 | do | | v | v | | | |
| 5147 | *Citrus webberii*, "Bontoc" | | | | | v | A variety reported from Bontoc to be of unusually good quality. |
| 5540 | do | | | v | v | | |
| 897 4 | do | | | | | v | |

*Table showing the degree of citrus canker affection in the citrus collection at the Lamao Experiment Station*—Continued.

| P. I. No.— | Botanical name. | Canker affection. | | | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | Serious. | Medium. | Slight. | Nearly immune. | Immune. | |
| 2266 | *Citrus webberii* var. *montana* | | | | v | | Fruit rather seriously affected. |
| 5497 | do | | | | | v | |
| 5699-10 | *Citrus webberii* var | | | | v | | Very distinct type. |
| 5699-7 | do | | | | v | | |
| 3383 | *Citrus* sp. near *webberii* | | | v | | | Of Saigon origin. |
| 615 | *Aegle glutinosa* | | v | v | | | |
| 5525 | *Citrus* sp | | | v | v | | |
| 5189 | do | | | v | v | | |
| 5528 | do | | | | | v | |
| 5550 | *Citrus* hybrid | | | | | v | The hybrids have been originated by T. W. Swingle, Bureau of Plant Industry, U. S. D. A. Received at Lamao, 1916. |
| 5553 | do | | | | | v | |
| 5556 | do | | | | | v | |
| 5554 | do | | | | | v | |
| 5555 | do | | | | | v | |
| 5557 | do | | v | v | | | |
| 5558 | do | | | | v | | |
| 5561 | do | | | v | | | |
| 5562 | do | | | | | v | |
| 5565 | do | | | | | v | |
| 5566 | do | | | | v | | |
| 5567 | do | v | v | | | | |
| 5568 | do | | | | | v | |
| 5570 | do | | v | v | | | |
| 5571 | do | | | | | v | |
| 5572 | do | | | | v | | |
| 5573 | do | v | | | | | |
| 5574 | do | | | | | v | |
| 5575 | do | | | v | | | |
| 5590 | do | | | | | v | |
| 5578 | do | | | v | | | |
| 5579 | do | | | v | | | |
| 5580 | do | | | | v | | |
| 5581 | do | | v | v | | | |
| 5582 | do | v | | | | | |
| 5583 | do | | | v | | | |
| 5584 | do | v | | | | | |
| 5585 | do | | | | v | | |
| 5586 | do | | v | | | | |
| 5587 | do | | | v | | | |
| 5588 | do | | | v | | | |
| 5589 | do | | | | | v | |
| 5576 | do | | | | v | | |
| 5592 | do | | | | | v | |
| 5593 | do | | | v | | | |
| 5594 | do | | | | | v | |
| 5595 | do | | | v | | | |
| 5597 | do | | | v | | | |
| 5598 | do | | | v | | | |
| 5599 | do | | v | v | | | |
| 5651 | do | | | v | | | |
| 5653 | do | v | v | | | | |
| 5654 | do | v | v | | | | |
| 5655 | do | | | v | | | |
| 5656 | do | | | v | | | |
| 5658 | do | | | | | v | |
| 5662 | do | | | v | | | |
| 5563 | do | v | | | | | |

# THE PRINCIPAL FORAGE CROPS OF THE PHILIPPINES.

By F. C. KINGMAN, *Chief, Agronomy Section,* and E. D. DORYLAND, *Station Superintendent.*

Other than the native "zacates" (grasses), which are the sole forage crops in some localities, the following crops are the principal forages of the Islands. Although some of the crops enumerated below are not as yet widely diffused throughout the Archipelago, yet there is every possibility that they will be so diffused, in the course of a very few years, since the carabao and hardy native ponies subsist almost entirely on forage, and receive little or no grain food. Hence, there is every likelihood that any crop of a forage nature that is well adapted to the diverse conditions of the Islands will receive consideration from both native and foreign farmers.

## GUINEA GRASS.

*Panicum maximum.* (Pl. VIII.)

Guinea grass, a native of tropical Africa, is cultivated at the present time for forage purposes, throughout practically the whole of the Tropics. Its introduction into the Philippine Islands dates from 1907, when twenty root clumps of a shipment from the Hawaiian Experiment Station, to the Philippine Bureau of Agriculture, arrived in Manila in good condition. In 1909, these twenty roots had furnished sixty-one thousand plants for distribution, and early in 1914, the Bureau of Agriculture had distributed to different concerns and private individuals throughout the Islands, some hundreds of thousands of root bunches, each bunch containing from twelve to twenty-five stems. This tremendous increase was made possible by a process of divisioning and replanting every few months. It is estimated at the present time, 1917, that the twenty root clumps received in 1907, are now the parents of some millions of plants, distributed throughout the Archipelago, mostly to large estates, where the crop enjoys high favor as a forage for horses and cattle.

Under Philippine conditions Guinea grass grows best where plenty of water is available for irrigation purposes during the dry season. The grass readily responds to almost any kind of

organic nitrogenous fertilizer, and when well watered and fertilized, produces green forage 2 to 2.5 meters high, and to the amount of about 50 metric tons per hectare per cutting. It can be cut approximately five times each year. Without fertilization and proper irrigation, however, production is between 15 to 20 tons of green feed per hectare per cutting, and thus drops from its higher level of production to that of the native "zacates."

Guinea grass grows well in most Philippine soils, but prefers the open well-drained sandy loams found in the valleys to that of the heavier types.

To get the maximum yield, with the methods of culture practised in the Islands, it is necessary to dig up the roots and replant them to a new field every two, or not more than four years; this sort of procedure is a very simple operation and is practised where the crop is cultivated on an intensive basis.

The method of planting employed throughout the Islands is the row system, that is, the rows are planted 1 meter apart, and the plants are set one-half meter apart in the row, giving a stand of 20,000 plants per hectare; this applies to that planted for forage purposes, but that planted for pasturage is set 60 to 80 centimeters apart, and the plants are set about three to four per meter in the row.

The analysis of the green plant as compared with other Philippine-grown grasses, is as given in the following table:

| | Balili zacate. | Barit. | Guinea grass. | Manimanihan. |
|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Water | 82.56 | 68.84 | 77.85 | 67.39 |
| Ash | 2.19 | 6.64 | 2.85 | 3.69 |
| Protein | 2.96 | 2.76 | 3.34 | 4.28 |
| Carbohydrates | 6.71 | 11.88 | 8.09 | 7.86 |
| Fat | .90 | 1.51 | .57 | 8.09 |
| Fiber | 4.68 | 8.37 | 7.30 | 8.69 |

## UBA (JAPANESE FORAGE CANE).

*Saccharum* sp. (Pl. IX, *a*.)

This is probably the most popular forage crop in the Philippines, because the Filipino farmer is more familiar with its planting than he is with the planting of any other forage crop. This familiarity with the planting methods is due to its similarity to sugar cane, large quantities of which are planted yearly, over nearly the whole of the Islands.

Uba cane is planted from points. These are set in rows 75 centimeters apart and three points per meter in the row. It

thus requires about 40,000 points to plant 1 hectare. This cane when allowed to obtain its full growth reaches the height of 1½ to 3 meters, and can be cut several times per annum, as it ratoons almost indefinitely. Twenty tons of green forage per hectare is considered a very moderate crop. Uba, like any other cane variety, requires a considerable amount of water during the dry weather for its best production. Consequently, in very dry sections where irrigation water is not obtainable, uba is to be avoided and some of the more drouth-resistant crops selected.

### SUDAN GRASS.

*Holcus sudanensis.* (Pl. IX, *b.*)

This remarkable forage plant, under Philippine conditions, grows to the height of 2 to 3 meters, and matures the first crop within three months from the time of planting.

The seed is sown in rows 75 centimeters to 1 meter apart, or is broadcasted upon well-prepared ground. Two kilos of seed are usually considered sufficient to plant 1 hectare, when planted in rows; broadcasting requires from three to four times this amount of seed. This grass grows very rank but stands up well for its extreme length. From three to five crops may be expected yearly, depending upon the local environment. The seed is usually planted just before the beginning of the rainy period so as to obtain the impetus of growth from the heavy rains. Sudan grass is perennial in the Philippines if not allowed to seed, and one planting is good for two or more years.

Sudan grass as compared with Guinea grass is equal in yield, but has the added advantage of requiring less water. The forage or hay is slightly coarse; however, if pastured or cut before the seed forms it is quite palatable to stock. It makes a good soiling crop for native cattle and carabao.

### DESERT INDIAN MAIZE.

*Zea mays* varieties.

During the latter part of 1914, three varieties of Indian corn obtained originally by the United States Department of Agriculture from the Pueblo Indian reservation, United States of America, were introduced into the Islands, and in 1917, six more varies were received by the Bureau from the same source. This corn in its native habitat is capable of reaching the surface when planted to the depth of 32 centimeters (Collins, Journal of Heredity, 1914), so there is not much danger of it not coming through, when planted to a good depth sufficient to obtain mois-

ture for germination during dry weather. It is purely a dry weather crop, and such it should be considered, as it grows luxuriantly under Philippine drought conditions, but fails almost entirely when planted during the wet weather.

This type of corn has the same coloration as those varieties in the United States known as "Squaw corn," that is, the kernels are of purple, blue, yellow, white, and red colors. The starchy portion of the kernels is somewhat powdery and the cuticle is fairly loose, but with due precautions the seed can be preserved from weevil attacks. The ears are short, averaging about 5 to 6 inches in length, but are of fair circumference.

This corn produces exceedingly well and reaches maturity in from sixty to eighty days from the time of planting. All these varieties are dwarfish in character, averaging less than 90 centimeters in height, and having a small stalk densely covered with foliage, sucker abundantly and develop to the roasting-ear stage within forty to fifty days from the time of planting.

For forage purposes, they are planted in rows 75 centimeters apart, 15 centimeters apart in the row, and are cut at a little past the roasting-car stage. Eighteen liters of seed is considered sufficient to plant 1 hectare, and at this rate of seeding 2 to 5 tons of dry feed can be expected from 1 hectare. No irrigation is necessary to start germination provided the seeds are planted in moist soil, and this can usually be obtained in well cultivated land at a depth of from 10 to 15 centimeters. A crop of about 3,750 liters of seed per hectare is obtained when left to mature.

## PEANUTS.

*Arachis hypogea.*

The Philippines have the necessary requirements for a peanut country, namely, a long growing season without frost, a high temperature, a sandy soil, and a dry season for harvesting the crop.

In the Philippine Islands, peanuts are planted so that they will ripen before or after the rainy season. If they mature during the rainy weather it is hard to handle the crop, and unless they are harvested immediately after ripening, they soon decay, or burst open and start to germinate. There are several varieties of peanuts that are grown in the Philippine Islands, the following being the most important: The Virginia runner, North Carolina, Virginia bunch, Improved Valencia and the Spanish (introduced from the United States), the large-India, large-native, Pondicherry-India, Japan-India, and the Spanish-India.

The names suggest the source of introduction and origin. Of these several varieties, the Pondicherry, the Spanish, the Virginia varieties, and the large native are perhaps the best known and the most widely grown.

Although in these Islands peanuts are not put to the many uses that are made of them in other countries, yet their rate of consumption is rapidly on the increase. During 1914, besides the amount produced in the Islands, $80,633 worth of peanuts were imported, most of which came from the neighboring coast of China. The above figure does not include those imported in the form of peanut butter, oil, etc.

Under Philippine conditions the Spanish peanut matures in from four to five months, while it requires from six to eight months for the larger varieties to mature. When planted in rows from 60 centimeters to 1 meter apart, 3,750 to 4,000 liters of unshelled peanuts per hectare can be expected, depending of course upon variety, season, etc.

Aside from the many varied uses of the nuts themselves the entire peanut plant is valuable both as a hay and forage crop.

The tops of the peanut plant when cut and cured in the same manner as cowpeas produce a very palatable hay which is almost equal in feeding value to some of the best hay plants of the Temperate Zone, for instance clover and alfalfa hay.

By planting the Spanish peanut in rows from 60 to 70 centimeters apart and quite closely in the row and giving the crop two or three cultivations, a yield of from 3 to 5 tons per hectare may be reasonably expected. After the hay is removed the pods can be turned out by means of a plow, cured, and stored for subsequent feeding, or hogs may be turned in to gather the crop.

Where the entire peanut plant is to be stored and used as a forage for feeding to stock the work of curing and caring for the vines is very much the same as in curing cowpea hay, although the peanut vines will cure more rapidly than those of the cowpea.

The vines may be plowed from the soil or pulled up by laborers, and after being allowed to lie exposed for a few hours are gathered together in windrows. After partially drying in the windrows the vines are put up in small shocks. The main object in handling peanut vines for forage is to properly cure the stems and nuts without losing the leaves, and in order to do this it is necessary to keep them in bunches and to dry them gradually. After the vines are dry they may be either stacked in the field or hauled to a shed and stored.

If for any reason it may be undesirable or impracticable to

make peanut hay or forage a convenient method of harvesting both vines and nuts is by pasturing the crop to hogs, cattle or carabaos.

Although the peanut is not a new crop in the Philippine Islands, its chance for future development as a stable crop may nevertheless be considered as one of the agricultural possibilities of the Islands, as its usage is becoming more common each year.

## COWPEAS.

*Vignia unguiculata.* (Pl. X.)

Cowpea varieties have been introduced into the Philippine Islands by the Bureau of Agriculture, with more or less success, for a period of several years. The greatest find along this particular line, however, has been the New Era, which has proved to have no rival for abundant growth and sound seed production, either from tropic or temperate-grown seed of other varieties, when subjected to Philippine conditions.

New Era cowpeas, as grown by the Bureau of Agriculture, have proved to be the best cover crop obtainable, for planting in such locations as banana plantations, papaya orchards, etc. Not only have they proved good nitrogen restorers, but they have aided materially in the killing of weeds, thus greatly reducing expenses for the upkeep of such plantations.

If such plantations as mentioned above are planted to cowpeas during the rainy season and if weeds are not too abundant, the broadcast method of planting is advisable, for usually sufficient water is available at this time to carry the crop through without injury to the other plants. However, when planted during the dry season, or when weeds are prevalent, the row method is employed and during the worst drought it is advisable to irrigate to insure a crop, and to prevent injury to the other plants. Where the row method is used, the rows are made 75 centimeters apart and seeded at the rate of five to six seeds to the one-half meter, but where the broadcast method is deemed advisable, the seeds are sown so as to allow 15 to 20 square centimeters for each fertile seed. Thus, if the seed is poor, thick planting is necessary.

On rich soils or on soils that have grown some other legume previously, these distances are increased. From 60 to 120 liters of seed are used to plant 1 hectare, depending upon whether the broadcast or row method is used.

The value of New Era cowpeas as a cover crop for banana orchards, etc., under conditions as mentioned above, is due to the fact that the vine runners are not of sufficient length to climb

(*a*) Guinea grass at the Lamao Experiment Station.

(*b*) Guinea grass; at the right fertilized with locusts; at the left unfertilized.

(*a*) Uba; Japanese forage cane.

(*b*) Sudan grass showing normal growth on ordinary soil, without fertilizer. Singalong Experiment Station.

(*a*) A field of new era cowpeas.

(*b*) Cowpeas as a cover crop.

(*a*) Non-sacchorine sorghum growing under typical Philippine Conditions. Singalong Experiment Station.

(*b*) Mungos on rice land.

(*a*) Field corn growing under Philippine conditions without special care.


(*b*) Typical ears of Philippine grown corn. Length is in inches.

the banana or papaya stalks for any considerable distance, thus eliminating the possibility of injury from climbing vines, which often occurs where running plants like the stizolobium are used.

As a catch crop, the New Era cowpea has proved to be at its best, as it requires only a short time, three to four months, for the crop to mature. In this length of time it has been known to store up 100 kilos or more of nitrogen to the hectare. Besides its value as a nitrogen gatherer, the forage that can be harvested from the New Era cowpea is a considerable item, and in a country like the Philippine Islands where alfalfa and clover do not grow, the hay thus obtained proves valuable as a food for animals.

The vines at any time are excellent forage, especially if partly dried. If cut just before maturity, from 3 to 7 tons of dry forage per hectare can be expected.

Cowpeas grow well during both the wet and dry seasons, but for haying purposes, planting is done during the latter part of the wet season so the crop can be cut during the dry weather.

As green manure and soiling crops, the cowpeas are very useful, as they grow prone upon the ground which makes them comparatively easy to plow under, especially for the small-type one-handled plows so common in the Philippines, while their low-growing, luxuriant growth has proved a tempting food for native hogs, sheep, chickens, and goats.

The young beans when fresh and green are similar to the garden bean as a vegetable food, and by some people are thought to be far superior, as the cowpeas at such a time have an exceptional flavor; they are used throughout almost the whole of the Islands for much the same purpose as green beans are used in America.

## NONSACCHARINE SORGHUMS.

*Holcus species.* (Pl. XI, *a*.)

This group is composed of the kafirs, sorghums, milos, feterita, etc., and is particularly well adopted to a dry climate, such as the dry season of the Philippines.

The following plants were introduced into the Islands by the Bureau of Agriculture in 1915, the seeds being obtained direct from the United States Department of Agriculture: Black-hulled white kafir, pink kafir, red kafir, feterita, doura, orange sorghum, Minnesota amber sorghum, gooseneck sorghum, dwarf hegari, honey sorghum, sumac sorghum, and dwarf milo.

These plants grew rapidly when planted and were admirably adapted to their new environment, producing all the way from

$8\frac{1}{2}$ up to $32\frac{3}{4}$ metric tons of green forage per hectare. The planting methods employed are the same as those used in the United States, namely, sown thickly in rows from 90 centimeters to 1 meter apart. The following is the calculated production of green forage per hectare as taken from the experimental data: White kafir, 12.2 tons; red kafir, 12.6 tons; orange sorghum, 17.2 tons; feterita, 12.25 tons; pink kafir, 9.5 tons; Minnesota amber sorghum, 18.25; goose neck, 8.5 tons; dwarf hegari, 13.25; honey sorghum, 25.5; sumac sorghum, 32.75; dwarf milo, 13.5; and black-hulled white kafir, 17 tons. It will be observed that the "sorghum" produced approximately twice the amount of green forage that the kafirs and milo did, and this is to be expected because of the normal ranker growth of the sorghums in favorable environments. All the plants produced exceedingly well, both in Manila and in Occidental Negros, maturing in from sixty to ninety days from the time of planting. A small amount of the seed has been distributed by the Bureau of Agriculture to different people, but there seems to be no great demand for the seed at present, because of the abundance of other forages that have already received a somewhat permanent foothold, in districts where forage is needed. Regardless of this fact, however, there is doubtless a great future in the Philippine Islands for the nonsaccharine sorghums as a dry-season forage, as they are well adapted to the climate, produce well, and are suitable feed for native stock.

## MUNGO.

*Phaseolus radiatus.* (Pl. XI, *b*.)

Mungo is a plant indigenous to the Old World, more probably to India, but is now quite generally cultivated throughout the Tropics. The plant is widely disseminated throughout the Philippines and has been cultivated for ages, but can scarcely be said to appear as spontaneous. The seed of mungos are of a variety of colors, those of the Philippines being yellow, black, and green, or a mixture of all three colors. Of these three varieties the green is far more popular than the others and is to be found under cultivation in practically every province of the Archipelago.

Three native varieties of mungo, one green seeded, one black seeded and one yellow seeded, were tested out by the Bureau of Agriculture at the Lamao station; all three varieties gave good results producing from one-half to three-fourths of a metric

ton of seed per hectare. One red variety introduced from Japan was also given a trial but failed to become properly acclimated, and had to be discarded. The mungo is used at the present time by up-to-date rice growers as a soil renovator, after the rice crop has been harvested, and it has proved quite successful for this purpose.

Mungo hay is somewhat similar to cowpea hay, and is harvested, gathered, and stored in the same way. The green plant is considered a good soiling crop for all kinds of live stock, more especially for hogs and chickens.

The mungo is one of the most popular legumes in the Philippines and is rightly so, because it is second to none as a green-manure, cover, and hay crop, when grown under the proper conditions.

## FIELD CORN.

*Zea mays.* (Pl. XII.)

The two principal varieties of corn in the Philippine Islands are the "Moro white," and "Calamba yellow," both of which are perhaps as well adapted to the diverse conditions of the Islands as any varieties that could be found. There are several other varieties that receive recognition, such as Lobo yellow, Cagayan yellow, etc., but they are not so widely distributed as the first two.

The ear length of these two varieties is considerably less than that of the average ear from the corn-belt states of America. The kernels are shallow and the ears lack cylindricalness, usually tapering uniformly, but to an extreme degree. The ears of the yellow variety somewhat resemble the northern type of American corn, being small, flinty or resinous, and having a more pop-corn appearance than the white variety, which is larger, and more cylindrical, but has larger cobs and a less compact type of ear.

The cuticle of the kernel of both varieties is hard and honey like, a characteristic very suitable to Philippine conditions, as such a condition of the cuticle is necessary to prevent wholesale consumption by weevils, "the bane of all Philippine seed growers."

The name "white Moro" is a misnomer, since the corn is a stable hydrid between Mexican June, a variety of American white corn, and a native white variety, and has nothing to do with Mindanao (Moroland), except that it is grown there as a field crop. The so-called "white Moro" variety is a very pro-

ductive corn, enjoying the greatest popularity and is used quite extensively as human food throughout the Islands. Sweet corn attracts ants so readily when planted that it cannot be grown successfully for roasting-ear purposes, unless great care is taken to preserve the seed from attack. Consequently, both white and yellow field corn are used for this purpose, but the white variety is generally preferred.

Corn is usually planted in the Philippines immediately at the end of, or sometimes after the end of the rainy season; that is, in such parts of the Islands as have a well defined rainy period.

Growing as it does only after the rainy season, corn has a certain amount of dry growing weather to endure, the amount of such weather of course depending upon whether planted in the early or late season. Due to the dry condition prevailing at this time, corn is given more space than it would be given were it planted in a more favorable environment. The planting distance is 1 meter between hills. Where the rainfall is evenly distributed throughout the year the corn is planted somewhat closer, the average distance being about 90 centimeters, and about three stalks per meter in the row. The yield per hectare under nominally good cultivation is from 3,600 to 4,800 liters of shelled corn per hectare. However, yields of 8,250 liters of shelled corn per hectare have been realized in the Calamba, Laguna, district.

Although field corn is not much used as a forage except in a few localities where the live-stock industry has taken a hold, yet its potential possibilities as such will be of great value as the live-stock industry of the country develops, since it is already widely diffused throughout the Islands. Corn is cherished as a human food in all islands of the Archipelago, but more particularly in the southern, or Visayan group.

No one knows the exact date, or place from which corn was first introduced into the Philippines; some hold out for China as the source of introduction, but the greater consensus of opinion is unanimous in the belief that it was introduced from America by the early Spaniards. At any rate it is of almost ancient cultivation since it is to be found growing under cultivation in out of the way places, where the residents insist it has been cultivated for generations.

The use of corn leaves for fodder, while not generally practised here, is, nevertheless, to be recommended. As soon as the ears reach the stage of maturity when no milk can be pressed out of

the grains, the fodder is ready for pulling. Pulling the leaves at this time will not materially reduce the yield of corn. Only green blades should be pulled.

The leaves are tied in small bundles and hung over the ear which remains on the stalk. The bundles are allowed to cure in the sun for a day or two, then collected and stacked in the field. When thoroughly cured the fodder may be stored under sheds in bulk and will keep for quite a long time. Corn leaves saved in this manner make a hay which is a palatable feed for stock and which is an acceptable substitute for the more nutritive hays.

# EXPERIMENTS ON THE TREATMENT OF RINDERPEST WITH VARIOUS DRUGS.[1]

By WILLIAM HUTCHINS BOYNTON, *Pathologist, Bureau of Agriculture.*

The following experiments have been accomplished at various times during a period of approximately six and one-half years. The veterinary division, Bureau of Agriculture, is frequently confronted with men who claim to have specific cures for rinderpest, and when their so-called cures are given the proper trial they have, up to the present time, been found lacking in curative powers. On account of these frequent claims and rumors of cures it was thought advisable at this time to publish the results of the Bureau experiments on various drugs, as these results may aid in obtaining a better idea of a method of treatment, and it may also give a clearer insight into the location of the fountain head of the virus in the animal body.

In the laboratory only highly susceptible animals are used, which are obtained from localities where rinderpest has supposedly never existed or where a considerable number of years have elapsed since the last appearance of the disease. A highly virulent strain of virus is also used in all the work. The virulence of the strain is kept up by taking the infective material from animals in the early stage of the disease, i. e., the first or second day after the initial rise in the temperature. If the infective material is obtained from animals in the last stages of the disease the virus soon loses its potentcy, undoubtedly due to the action of the antibodies upon it which have a tendency to weaken the virus and render the results unreliable.

If the records of the veterinary division, Bureau of Agriculture, are consulted it will be noticed that in those localities where the cures for rinderpest have been so successful, the recoveries of animals under normal conditions have been very high, averaging

[1] The following abbreviations are used in the text: a. m., morning; p. m., afternoon; V. B. virulent rinderpest blood; D., diarrhea; N. E., not eating; E. L., eating little; D., N. E., diarrhea, not eating; and D., E. L., diarrhea, eating little.

in many instances in the neighborhood of 60 per cent. If the person administering the cure is at all shrewd he can easily eliminate the doubtful cases and in that way obtain a high percentage of recoveries from his drugs, providing the drugs are not too harmful to the animals and are administered in small enough doses.

The drugs used in the following experiments were as follows: (1) Eosin; (2) medicinal methylene blue (Merck); (3) cacodylate of soda; (4) atoxyl; (5) quinine sulphate; (6) camphorated oil; (7) creolin; (8) permanganate of potash; (9) ergot; (10) iodine; (11) potassium iodide; (12) gentian violet; (13) arecolin hydrochloride; (14) nuclein; (15) formalin; (16) chlorazene; (17) castor oil; (18) alcohol; (19) fluid extract of *nux vomica;* and (20) fluid extract of gentian.

With the small amount of experimentation which has been given to each drug, no promising results have been obtained by the method in which they were administered and the dosage in which they were given.

In all the experiments where sodium-chloride solution was made use of to dilute the drug for intravenous and intraperitoneal injections, 0.85 per cent was used. It was found when giving large intravenous and intraperitoneal injections that if the fluid was warmed to about 41° C. the animals withstood the injections with much less discomfort than when the solutions were cooler. All the large intravenous injections were performed in the manner illustrated in Plate XIII.

### EOSIN.

This aniline dye was used with the idea that it might have a special affinity for the virus of rinderpest as it is one of the diffuse stains and penetrates well.

#### EXPERIMENT 1.

Batanes bull 3153, which had contracted rinderpest by exposure to sick animals and had run a high temperature for 48 hours, was injected subcutaneously on the afternoon of May 30, 1911, with 2 grammes of Grubler's W. Gelb eosin dissolved in 100 cubic centimeters of sterile distilled water.

June 1, this animal's temperature subsided to normal, but it developed inappetence and diarrhea and died June 3, presenting good lesions of rinderpest upon autopsy. The subcutaneous and mesentery tissues had taken on a pinkish coloration, resulting from the free distribution of eosin through the body, which apparently had no ill effects upon the virus of rinderpest.

### MEDICINAL METHYLENE BLUE.

This drug was used in experiments 2 and 47 with the idea that if perchance the virus of rinderpest was an intercorpuscular organism, this dye might have a direct action upon it, as is the case in malaria. Its antipyretic and anodyne actions were also considered.

#### EXPERIMENT 2.

Batanes bull 3116 was injected on May 23, 1911, with 30 cubic centimeters of filtered blood handled as follows: Five cubic centimeters of virulent rinderpest blood from bull 3135 was diluted up to 500 cubic centimeters with sterile 0.85 per cent sodium-chloride solution; this diluted blood was then passed through an N. Bergerfeld filter under 3 kilogrammes pressure.

This animal presented its first rise in temperature on the morning of May 28, registering 39.2° C.

During the afternoon of May 29, or 36 hours after the first rise in temperature, this animal was injected subcutaneously with 2 grammes of Merck medicinal methylene blue dissolved in 100 cubic centimeters of sterile distilled water.

May 30, this animal's urine was dark blue in color. Its visible mucous membranes also took on a bluish coloration.

May 31, D., E. L.

June 1–3, D., N. E.

July 3, died, presenting good lesions of rinderpest upon autopsy.

The methylene blue thus administered had no apparent ill effect upon the virus of rinderpest.

### CACODYLATE OF SODA.

This drug was tried with the idea that it might have an action upon the virus of rinderpest similar to that which it has upon the *Treponema pallidum*, although arsenobenzol (salvarsan, 606) has been tried on rinderpest with negative results. (The reference to the experiments with salvarsan cannot be located).

#### EXPERIMENT 3.

Carabao 3088 had contracted rinderpest by exposure to sick animals.

May 17, 1911, fourth day of temperature, this animal was injected intravenously in the femoral vein with six grains of cacodylate of soda. The animal's temperature subsided to normal in one and one-half days after the injection, but it suffered severely from photophobia; D., N. E.

Died the night of May 19, presenting marked lesions of rinderpest.

EXPERIMENT 4.

*Batanes bull 3158.*—This animal had been injected with virulent rinderpest blood.

May 19, 1911, which was the second day of temperature, this animal was injected intravenously in the femoral vein with 5.25 grains of cacodylate of soda. The temperature started down on May 20, but the animal presented marked symptoms of photophobia.

May 21–23, D., N. E.

This animal died May 23, presenting marked lesions of rinderpest upon autopsy.

EXPERIMENT 5.

*Batanes bull 3135.*—This animal had been injected with virulent rinderpest blood.

May 23, 1911, eighteen hours after the first rise in temperature, this animal was injected intravenously in the femoral vein with 3 grains of cacodylate of soda.

May 24, this animal presented symptoms of photophobia.

May 25, E. L.

May 26–28, D., N. E.

May 28, died of rinderpest, presenting marked lesions.

From the results of experiments 3, 4, and 5, it will be seen that cacodylate of soda as it was used in these cases had no ill effect upon the virus of rinderpest, and if anything aggravated the disease causing a much more pronounced photophobia than is normally present in rinderpest and also more pronounced intestinal lesions than are usually noticed. From these results it would appear that arsenic compounds are contraindicated in rinderpest.

ATOXYL.

This drug was tried because it has such a pronounced action in clearing the blood stream of Trypanosomes in cases of surra infection, and there was a possibility that it might have a similar action upon the virus of rinderpest.

EXPERIMENT 6.

*Batanes bull 3119.*—This animal had been injected with 30 cubic centimeters of virulent rinderpest blood serum [1] on July 8, 1911.

[1] Virulent rinderpest blood was allowed to stand in the ice box for 24 hours, then the serum was drawn off and injected.

July 11, it presented a rise in temperature, registering, P. M., 40.2° C.

July 12, it developed a diarrhea.

July 14, which was the third day after the initial rise in temperature, this animal was injected subcutaneously with 5 grammes of atoxyl dissolved in 60 cubic centimeters of sterile distilled water.

The animal's temperature dropped to slightly high normal shortly after the injection, registering 39.4° C. but it presented marked symptoms of photophobia.

July 16, this animal died, presenting marked lesions of rinderpest upon autopsy.

The atoxyl gave symptoms similar to those of the cacodylate of soda and appeared to stimulate the virus instead of retarding its action.

### QUININE SULPHATE.

This drug was used with the idea that it might have an action upon the virus of rinderpest similar to that which it has upon malaria. Its antipyretic action was also taken into consideration.

#### EXPERIMENT 7.

*Batanes bull 4315.*—This animal was injected on November 24, 1911, with 25 cubic centimeters of rinderpest blood which had been kept in a clotted form in a large test tube for 96 hours in the incubator at 37° C. The clotted blood was taken from the test tube and macerated in a sterile mortar with a 5 per cent potassium-citrate solution and the liquid material thus obtained was injected.

November 30, A. M., this animal presented its first rise in temperature, registering 39.6° C.

December 1–2, D., E. L.

December 3–4, D., N. E.

December 4, this animal was given quinine sulphate in capsules per orem in the following doses:

8.30 a. m., 5 grammes.
11.30 a. m., 5 grammes.
2.30 p. m., 5 grammes.
5.30 p. m., 5 grammes.

This animal died during the night of December 4 and presented good lesions of rinderpest upon autopsy.

From this experiment it will be noted that the animal received 20 grammes of quinine sulphate per orem with no effect upon the disease, although the animal was in the last stages of the disease when the treatment was undertaken.

EXPERIMENT 8.

(*Quinine sulphate and ergot.*)

*Fuga carabao 67.*—This animal was injected on January 28, 1917, with 50 cubic centimeters of V. B. from carabao 65.

January 29, this animal received intraperitoneally 8 grammes of quinine sulphate dissolved in 1,000 cubic centimeters of sterile distilled water slightly acidulated with sulphuric acid. The injection was made at this time to try and abort the disease. In two hours after this injection the carabao was lying down, eating little and presenting slight nervous symptoms.

January 30, this animal was standing up and eating well but had an a. m. temperature of 38.9° C.; p. m. temperature 39.5° C.

January 31, p. m. temperature 40.5° C. The animal looked bright and was eating well.

February 1, a. m. temperature 39.9° C.; administered intraperitoneally 10 grammes of quinine sulphate dissolved in 1,000 cubic centimeters of acidulated 0.85 per cent sodium-chloride solution; p. m. temperature, 40° C.; N. E.; carabao standing up.

February 2, a. m. temperature 39° C.; diarrhea starting; slight discharge from eyes; administered subcutaneously 8 cubic centimeters fluid extract of ergot; p. m. temperature 39.8° C.; D., N. E.

February 3, a. m. temperature 39.7° C.; animal very sick; sunken eyes; arched back; drooling; grinding teeth; swallowing frequently; D., N. E.; blood-stained chunks of mucus in feces; administered 10 cubic centimeters of fluid extract of ergot subcutaneously.

February 4, carabao 67 found dead in the morning; autopsy presented good lesions of rinderpest.

EXPERIMENT 9.

(*Quinine sulphate and iodine.*)

*Batanes cow 4168.*—This animal was injected January 19, 1917, with 50 cubic centimeters of V. B. from bull 4164.

January 22, this animal presented its first rise in temperature, registering, a. m., 39.7° C.; administered intraperitoneally 2 grammes of quinine sulphate dissolved in 500 cubic centimeters of acidulated sodium-chloride solution and intravenously with 1,000 cubic centimeters of sodium-chloride solution in which was dissolved 0.75 grammes of iodine and 2 grammes potassium iodide; p. m. temperature 39.7° C.; muzzle moist; urine dark.

January 23, a. m. temperature 40° C.; animal looked bright; eating; feces slightly coated with mucus containing a few flakes of blood; administered intraperitoneally 3 grammes of quinine

sulphate dissolved in 500 cubic centimeters of acidulated 0.85 per cent sodium-chloride solution; p. m. temperature 40.5° C.; animal active; muzzle moist; nostrils looked normal; E. L.

January 24, a. m. temperature 39.5° C.; no diarrhea; looked bright; E. L.; administered intraperitoneally 3 grammes of quinine sulphate dissolved in 500 cubic centimeters of acidulated sodium-chloride solution.

P. m. temperature 40° C.; N. E.

January 25, a. m. temperature 39° C.; slight diarrhea; N. E.; swallowing frequently; grinding teeth; looked fairly bright; administered intraperitoneally 3 grammes of quinine sulphate dissolved in 500 cubic centimeters of acidulated sodium-chloride solution.

P. m. temperature 39.6° C.; D., N. E.

January 26, cow 4168 found dead in the morning; autopsy presented marked lesions of rinderpest; intestinal hemorrhage very pronounced.

### EXPERIMENT 10.

(*Quinine sulphate, iodine and ergot.*)

*Batanes cow 4172.*—This animal was injected January 22, 1917, with 50 cubic centimeters of V. B. from 4186.

January 25, this animal presented its first rise in temperature, registering, p. m., 40.3° C.

January 26, a. m. temperature 39.3° C.; D., N. E.; administered intraperitoneally 5 grammes of quinine sulphate dissolved in 500 cubic centimeters of acidulated sodium-chloride solution. It was also injected intravenously with 1,000 cubic centimeters of sodium-chloride solution in which had been dissolved 1.5 grammes of iodine and 4 grammes of potassium iodide. The animal withstood the injection well. P. m. temperature was 38.4° C., which was the average normal temperature for the healthy animals this day.

January 27, a. m. temperature 38.2° C.; D., N. E.; animal did not possess good coördination of movement; muzzle moist; administered subcutaneously 8 cubic centimeters fluid extract of ergot; p. m. temperature 38.8° C.

January 28, a. m. temperature 37.7° C.; D., N. E.; animal lying down; respiration catchy; blood in feces; large amount of mucus; administered subcutaneously 5 cubic centimeters of fluid extract of ergot.

P. m. temperature 38.8° C.; diarrhea better in appearance; breathing regular; lying down; N. E., but drinking a little.

January 29, animal found dead in the morning. Upon autopsy

the fauces presented good lesions of rinderpest. The intestinal tract did not show marked hemorrhagic lesions.

### IODINE.

This drug was experimented with after reviewing the results of work done by Lambert (1) in which he proves that iodine can be used in strong enough dilution to destroy staphlococci and still have no deleterious action upon living tissue cells. It was thought that by using iodine in sufficiently large doses there might be a possibility of destroying or attenuating the virus to such an extent that the animal would be able to develop resistance enough to recover. Potassium iodide was used to facilitate the solution of iodine and to also have a direct action upon the lymphatic system which is markedly affected in rinderpest.

#### EXPERIMENT 11.

(*Iodine and potassium iodide.*)

*Batanes bull 4164.*—This animal was injected January 13, 1917, with 50 cubic centimeters of V. B. from No. 4165.

January 16, this animal presented a rise in temperature, registering, p. m., 40° C.

January 17, a. m. temperature 39.7° C.; p. m., 40.2° C.; diarrhea.

January 18, a. m. temperature 39.5° C.; D., N. E.; administered intravenously 1,000 cubic centimeters of sodium-chloride solution in which was dissolved 0.5 gramme of iodine and 1 gramme of potassium iodide; withstood injection well; p. m. temperature 39.8°C.

January 19, a. m. temperature 37.4° C.; D., N. E.; animal very sick; lying down; thick mucous discharge from nose; eyes sunken; grinding teeth; swallowing frequently; blood and mucus in feces; catchy respiration.

This animal died during the morning of the 19th. Upon autopsy it presented marked intestinal lesions of rinderpest.

### CREOLIN.

This disinfectant was used with the idea of trying to disinfect the blood, by either killing or attenuating the virus of rinderpest to such an extent that the animal would be able to acquire enough resistance to combat the disease.

#### EXPERIMENT 12.

*Davao carabao 3271.*—This animal was injected November 14, 1911, with 50 cubic centimeters of V. B. from No. 3225.

November 21, this animal presented its first rise in temperature, registering, p. m., 39.9° C.

November 25–26, D., N. E.; congested eye; erosions in mouth; rash under tail.

November 27, D., N. E.; administered intravenously 1,000 cubic centimeters of 1.5 per cent creolin solution in 0.85 per cent sodium chloride; animal withstood the injection well.

November 28–29, D., N. E.; animal very sick.

November 30, animal found dead in the morning; typical lesions of rinderpest upon autopsy.

### EXPERIMENT 13.

*Batanes bull 3306.*—This animal was injected on November 21, 1911, with 25 cubic centimeters of V. B. which had been kept in a test tube at 37° C. for 24 hours.

November 26, this animal presented an a. m. temperature of 39.2° C.; p. m., 41° C.

November 27, administered intravenously 1,000 cubic centimeters of a 1.5 per cent creolin solution in 0.85 per cent sodium chloride; the animal withstood the injection well.

November 29, N. E.

November 30, D., N. E.; administered intravenously 1,000 cubic centimeters of a 3 per cent creolin solution in 0.85 per cent sodium chloride; the animal withstood the injection well.

December 1–5, D., N. E.

December 6, died during the morning, presenting typical lesions of rinderpest.

### EXPERIMENT 14.

*Davao carabao 3183.*—This animal was injected on November 29, 1911, with 50 cubic centimeters of V. B. from No. 3307.

December 3, this animal presented its first rise in temperature, registering, p. m., 40.2° C.

December 5, D., N. E.; administered intravenously 1,000 cubic centimeters of a 3 per cent creolin solution in distilled water; also given a weak creolin solution to drink.

December 6, D., N. E.; blood in urine.

December 7, D., N. E.

December 8, died during the morning, presenting good lesions of rinderpest.

### EXPERIMENT 15.

Testing the infectivity of an animal's blood which had been given a 3 per cent creolin solution intravenously.

*Batanes bull 3314*.—December 6, 1911, this animal was injected with 25 cubic centimeters of blood taken from carabao 3183, 24 hours after this carabao had been injected intravenously with 1,000 cubic centimeters of a 3 per cent creolin solution. This injection was made to ascertain whether the virus had been killed in the blood by this heavy injection of creolin.

December 9, this animal presented a rise in temperature, registering, a. m., 39.2° C.; p. m., 40.1° C.

December 11–12, E. L.

December 13–14, D., E. L.

December 15–21, D., N. E.

December 22–23, bloody D., N. E.

December 24, this animal died, presenting good lesions of rinderpest upon autopsy.

This proves that the virus was in virulent form in the blood of carabao 3183 at the time it was drawn and that the creolin had apparently no detrimental effect upon the virus.

### PERMANGANATE OF POTASH.

Like creolin, this drug was tried for its antiseptic effect and its possible attenuation upon the virus. Walker (2) has used permanganate of potash on animals sick with rinderpest and has obtained some favorable results. However, he was working with animals having a high natural immunity to the disease, which undoubtedly accounts for much of his success.

### EXPERIMENT 16.

*Batanes bull 3307*.—This animal was injected on November 22, 1911, with virulent rinderpest blood which had been kept in a test tube in a clotted form for 48 hours at 37° C.

November 27, this animal presented its first rise in temperature, registering, a. m., 39.7° C.; p. m., 40.6° C.

November 29, diarrhea beginning.

November 30, D., N. E.; administered subcutaneously 900 cubic centimeters of a 1–2000 solution of permanganate of potash in physiological salt solution.

December 1–2, D., N. E.

December 3, this animal was found dead in the morning and presented good lesions of rinderpest upon autopsy.

### EXPERIMENT 17.

*Batanes bull 3309*.—This animal was injected on November 23, 1911, with 25 cubic centimeters of virulent rinderpest blood which had been kept in a test tube in a clotted form for 72 hours at 37° C.

November 29, bull 3309 presented its first rise in temperature, registering, p. m., 40.2° C.

December 1, E. L.; administered intravenously 1,000 cubic centimeters of a 1–1000 solution of potassium permanganate in physiological salt solution.

December 2, E. L.

December 3–4, D., E. L.

December 5, D., N. E.

December 6, died, presenting good lesions of rinderpest.

EXPERIMENT 18.

*Batanes bull 3315.*—This animal was injected on November 24, 1911, with 25 cubic centimeters of virulent rinderpest blood which had been kept in a test tube in a clotted form for 96 hours at 37° C.

November 30, bull 3315 presented its first rise in temperature, registering, a. m., 39.6° C.; p. m., 40.8° C.

December 1, D., E. L.

December 2, D., E. L.; administered intravenously 1,000 cubic centimeters of a 1–500 solution of potassium permanganate in physiological salt solution.

December 3, D., N. E.

December 4, D., N. E.; died during the afternoon, presenting good lesions of rinderpest.

EXPERIMENT 19.

*Davao carabao 3184.*—This animal was injected on November 29, 1911, with 50 cubic centimeters of V. B. from No. 3307.

December 4, carabao 3184 presented its first rise in temperature, registering, p. m., 40.1° C.

December 5, a 1–300 solution of potassium permanganate was being administered intravenously, but the animal died during the injection.

From the four preceding experiments, it will be noticed that potassium permanganate, whether administered subcutaneously or intravenously, had apparently no detrimental effect upon the virus of rinderpest.

FORMALIN.

This disinfectant was used on account of its potent antiseptic value, with the idea of destroying or attenuating the virus of rinderpest to such an extent that the animal would be able to recover.

Method of giving the intravenous injection when a large quantity of fluid is administered.

A small canula is inserted into the jugular vein, and as soon as the blood flows freely from the canula the flask is inverted and the fluid contents allowed to run by gravity through the rubber tubing. As soon as the air is expelled from the tubing it is connected with the canula. The flow of the liquid administered can be regulated by pressure applied to the tubing with the thumb and fore finger. The animal's respiration should be watched very carefully as a slight catch in the respiration is an indication that the drug is being administered too rapidly. As a rule, it requires from 8 to 12 minutes to administer 1,000 cubic centimeters of the various diluted drugs mentioned in the accompany ing paper.

EXPERIMENT 20.

*Dalupiri carabao 3182.*—This animal was injected on November 29, 1911, with 50 cubic centimeters of V. B. from No. 3307.

December 3, this animal presented its first rise in temperatnre registering, p. m., 40.9° C.

December 4, administered intravenously 1,000 cubic centimeters of a 1–4000 formalin solution in physiological salt solution.

December 6–7, N. E.

December 8, D., N. E.

December 9, D., E. L.

December 12, temperature normal; eating; no diarrhea. This animal made a good recovery.

EXPERIMENT 21.

*Chinese bull 743.*—Contracted rinderpest by exposure during shipment between Hongkong and Manila. This animal was in the last stages of rinderpest when treatment was tried. Bloody D., N. E.; catchy respiration; marked discharge from nostrils; still able to stand up.

July 14, 1917, administered intravenously 1,000 cubic centimeters of sodium-chloride solution to which was added 5 cubic centimeters of 40 per cent formalin. This animal died during the injection, about 600 cubic centimeters having been administered when death occurred.

EXPERIMENT 22.

*Chinese bull 742.*—Contracted rinderpest by exposure during shipment between Hongkong and Manila. This animal was very sick; bloody diarrhea; N. E., but was strong.

July 14, 1917, administered intravenously 1,000 cubic centimeters of 0.85 per cent sodium-chloride solution to which was added 1.5 cubic centimeters of 40 per cent formalin; animal withstood injection well.

July 15, D., N. E.; flakes of blood in feces; looked bright.

July 16, administered intravenously 1,000 cubic centimeters of sodium-chloride solution to which was added 2.5 cubic centimeters of 40 per cent formalin; withstood injection well.

July 17–20, looked very sick; D., N. E.

July 21, died this a. m.; typical rinderpest lesions.

EXPERIMENT 23.

*Fuga carabao 137.*—Contracted rinderpest by exposure to infected animals.

July 14, 1917, this animal presented its first rise in temperature, registering, p. m., 39.9° C.

July 15, a. m. temperature 39.6° C.; p. m., 40.4° C.; administered intravenously 1,000 cubic centimeters of sodium-chloride solution to which was added 2 cubic centimeters of 40 per cent formalin; withstood injection well.

July 16, D., N. E.; administered intravenously 1,000 cubic centimeters of sodium-chloride solution to which was added 2.5 cubic centimeters of 40 per cent formalin; withstood injection well.

July 17–20, D., N. E.; very sick; arched back; discharge from nostrils and eyes; blood in feces.

July 20, died, presenting good lesions of rinderpest.

EXPERIMENT 24.

*Jolo carabao 108.*—Contracted rinderpest by exposure to sick animals.

July 14, 1917, this animal presented its first rise in temperature, registering, a. m., 39.1° C.; p. m., 40.2° C.

July 15, administered intravenously 1,000 cubic centimeters of sodium-chloride solution to which had been added 2 cubic centimeters of 40 per cent formalin; withstood injection well.

July 16, D., E. L.; administered intravenously 1,000 cubic centimeters of sodium-chloride solution to which was added 2.5 cubic centimeters of 40 per cent formalin; withstood injection well.

July 17–19, D., N. E.; very sick.

July 19, died, presenting good lesions of rinderpest.

EXPERIMENT 25.

*Fuga carabao 131.*—Contracted rinderpest by exposure to sick animals.

July 14, 1917, this animal presented its first rise in temperature, registering, p. m., 39.6° C.

July 16, administered intravenously 1,000 cubic centimeters of sodium-chloride solution to which was added 2.5 cubic centimeters of 40 per cent formalin.

July 17–20, D., N. E.; very sick; blood in feces; muco-purulent discharge from nostrils and eyes.

July 20, died, presenting good lesions of rinderpest.

EXPERIMENT 26.

*Fuga carabao 132.*—Contracted rinderpest by exposure to sick animals.

July 14, 1917, this animal presented its first rise in temperature, registering, p. m., 40° C.

July 15, D., N. E.

July 16, D., N. E.; administered intravenously 1,000 cubic centimeters of sodium-chloride solution to which was added 2.5 cubic centimeters of 40 per cent formalin; withstood injection well.

July 17–18, D., N. E.; very sick.

July 18, died, presenting good lesions of rinderpest.

In the seven experiments just described it will be noted that one animal, Dalupiri carabao 3182, experiment 20, recovered from rinderpest. From the results of the other six experiments it may be granted that the administration of formalin played no part in the recovery, as this animal would undoubtedly have recovered without any treatment, as many animals do.

GENTIAN VIOLET.

Gentian violet was used in this experiment with the idea that it might have some direct action upon the virus. Russell (3) has found in his research work that gentian violet has a direct action upon protozoa in high dilution but has no detrimental effect upon tissue growing in vitro.

EXPERIMENT 27.

*Batanes bull 3931.*—Inoculated with rinderpest culture July 12, 1915.

July 16, this animal presented its first rise in temperature.

July 19, administered intravenously 1,000 cubic centimeters of sodium-chloride solution which had two grammes of gentian violet dissolved in it; took injection well.

July 21–22, N. E.

July 22, died, presenting good lesions of rinderpest, showing that the virus was not affected by the injection.

SERUM, NUCLEIN, AND ADRENALIN CHLORIDE.

Nuclein was used to try to develop a leukocytosis in the animals and thus increase their resistance, since one of the chief symptoms in rinderpest is a leukopenia.

Adrenalin chloride was used to tone up the blood vessel walls, since in rinderpest the virus or its product has a direct action upon the capillary walls causing them to lose their tone and thus become markedly distended with blood, which leads to

stasis, diapedesis, and exudation, the exudates coagulating and causing coagulation necrosis.

The serum was injected to give the animal a supply of antibodies and thus increase the resistance.

EXPERIMENT 28.

*Batanes bull 4165.*—This animal was inoculated on January 5, 1917, with 50 cubic centimeters of V. B. from bull 4162.

January 9, bull 4165 presented its first rise in temperature, registering, a. m., 39.2° C.; p. m., 40.2° C.

January 10, a. m., administered subcutaneously 200 cubic centimeters of antirinderpest serum and 15 cubic centimeters of nuclein solution; p. m., 10 cubic centimeters of adrenalin chloride.

January 11, a. m., administered subcutaneously 15 cubic centimeters of nuclein solution and 10 cubic centimeters of adrenalin chloride; p. m., administered 15 cubic centimeters of nuclein solution and 10 cubic centimeters of adrenalin chloride.

January 12, a. m., animal looked bright; slight diarrhea; temperature 38.5° C.; administered subcutaneously 15 cubic centimeters of nuclein solution and 10 cubic centimeters of adrenalin chloride; p. m., not looking so well; D., N. E.; administered 15 cubic centimeters of nuclein solution and 10 cubic centimeters of adrenalin chloride; temperature, 38.8° C.

January 13, animal very weak; temperature 36° C.; administered 10 cubic centimeters tincture of *Nux vomica* and 10 cubic centimeters of 70 per cent alcohol.

P. m., died, presenting good lesions of rinderpest.

Although the administration of nuclein and adrenalin chloride appeared to hold in check the more severe symptoms of rinderpest for some time, it has no effect upon the final termination of the disease.

DAKIN'S CHLORAZENE.

This antiseptic was used with the idea of either destroying or attenuating the virus of rinderpest to such an extent that the animal would be able to overcome the disease and recover.

Chlorazene was an ideal antiseptic to use since it has no corrosive action. It neither precipitates nor coagulates proteins, such as blood serum. It is practically nontoxic even when injected hypodermically. It is extremely stable, and is a powerful disinfectant in very high dilutions.

EXPERIMENT 29.

*Batanes bull 4322.*—This animal contracted rinderpest by exposure to sick animals.

July 15, 1917, bull 4322 presented its first rise in temperature, registering, a. m., 38.9° C.

July 17, administered intravenously 1,000 cubic centimeters of sodium-chloride solution in which was dissolved 13.8 grains of chlorazene; animal took injection without a struggle.

July 18, administered intravenously 1,000 cubic centimeters of sodium-chloride solution in which was dissolved 5 grammes of chlorazene; the animal began to eat immediately after injection.

July 20, administered intravenously 1,000 cubic centimeters of sodium-chloride solution in which was dissolved 5 grammes of chlorazene; withstood injection well.

This animal did not develop any symptoms of rinderpest except a rather high normal temperature and it was thought that a cure had possibly been located. It was left in immediate contact with animals in various stages of the disease.

July 29, bull 4322 again presented a high temperature, registering, a. m., 39° C.; p. m., 40° C.

August 1, as this animal continued to run a high temperature it was decided to administer chlorazene again. It received intravenously 1,000 cubic centimeters of sodium-chloride solution in which 4 grammes of chlorazene had been dissolved.

August 3, D., N. E.; administered intravenously 1,000 cubic centimeters of sodium-chloride solution in which 4 grammes of chlorazene had been dissolved.

August 4, D., N. E.; very sick.

August 5, died during night of August 4, presenting good lesions of rinderpest.

There is a question as to whether bull 4322 was suffering from rinderpest during the first administration of the drug. If it was suffering from rinderpest the chlorazene injections evidently destroyed the virus and also the few antibodies that may have been formed, as the second attack was as virulent as is noticed in any untreated animal and the administration of chlorazene during this attack had no ill effect upon the virus.

### EXPERIMENT 30.

*Fuga bull 4305.*—This animal contracted rinderpest by being inoculated with material from bull 4298.

July 17, 1917, p. m. temperature 40.3° C.

July 18, administered intravenously 1,000 cubic centimeters of sodium-chloride solution in which was dissolved 2 grammes of chlorazene; animal withstood injection well.

July 19, administered intravenously 1,000 cubic centimeters of

sodium-chloride solution in which was dissolved 5 grammes of chlorazene.

July 20, administered intravenously 1,000 cubic centimeters of sodium-chloride solution in which was dissolved 5 grammes of chlorazene.

July 21–22, N. E.

July 23, bloody diarrhea; N. E.; administered 2,000 cubic centimeters of sodium-chloride solution in which 10 grammes of chlorazene had been dissolved.

July 24, found dead in the morning; good lesions of rinderpest.

EXPERIMENT 31.

*Jolo carabao 96.*—This animal contracted rinderpest by exposure to sick animals.

July 18, 1917, carabao 96 presented its first rise in temperature, registering, a. m., 39° C.; administered intravenously 1,000 cubic centimeters of sodium-chloride solution in which was dissolved 3 grammes of chlorazene.

July 19, D.; administered intravenously 1,000 cubic centimeters of sodium-chloride solution in which 5 grammes of chlorazene had been dissolved.

July 20, D., N. E.; administered intravenously 2,000 cubic centimeters of sodium-chloride solution in which had been dissolved 10 grammes of chlorazene.

July 21, D., N. E.; sunken eyes; discharge from nostrils; arched back; lopping ears; ulcers in mouth.

July 22, D., N. E.; administered intravenously 2,000 cubic centimeters sodium-chloride solution in which 10 grammes of chlorazene had been dissolved.

July 23, found dead in the morning; good lesions of rinderpest.

EXPERIMENT 32.

*Fuga carabao 129.*—This animal contracted rinderpest by exposure to sick animals.

July 18, 1917, carabao 129 presented its first rise in temperature, registering, p. m., 39.6° C.

July 19, administered intravenously 1,000 cubic centimeters of sodium-chloride solution in which was dissolved 6 grammes of chlorazene.

July 20, D., N. E.; administered intravenously 1,000 cubic centimeters of sodium-chloride solution in which was dissolved 5 grammes of chlorazene.

July 21, D., N. E.; administered intravenously 2,000 cubic

centimeters of sodium-chloride solution in which was dissolved 12 grammes of chlorazene.

July 22, D., N. E.; very sick.

July 23, bloody diarrhea; N. E.; sunken eyes; discharge from nostrils and eyes; ulcers in mouth; swallowing frequently; catchy respiration.

July 24, found dead in the morning; marked lesions of rinderpest.

EXPERIMENT 33.

*Batanes bull 4314.*—This animal contracted rinderpest by exposure to sick animals.

July 20, 1917, bull 4314 presented an a. m. temperature of 40.2° C.; administered intravenously 1,000 cubic centimeters of sodium-chloride solution in which 6 grammes of chlorazene was dissolved.

July 21, administered intravenously 2,000 cubic centimeters of sodium-chloride solution in which 12 grammes of chlorazene had been dissolved; withstood injection well.

July 22, bloody diarrhea; N. E.

July 23, bloody diarrhea; N. E.; administered intravenously 1,000 cubic centimeters of sodium-chloride solution in which 5 grammes of chlorazene had been dissolved; also intraperitoneally 1,000 cubic centimeters of sodium-chloride solution in which 5 grammes of chlorazene had been dissolved.

July 24, bloody diarrhea; N. E.

July 25, D., N. E.; flakes of blood in mucus.

July 26, D., N. E.; flakes of blood in mucus; administered intravenously 1,000 cubic centimeters of sodium-chloride solution in which 4 grammes of chlorazene had been dissolved.

July 27, found dead in the morning; typical lesions of rinderpest.

EXPERIMENT 34.

*Fuga bull 4311.*—This animal contracted rinderpest by exposure to sick animals.

July 20, 1917, bull 4311 presented its first rise in temperature, registering, a. m., 38.8° C.

July 21, D., N. E.; administered intravenously 2,000 cubic centimeters of sodium-chloride solution in which 12 grammes of chlorazene had been dissolved; animal withstood the injection well.

July 22, found dead in the morning; good lesions of rinderpest.

EXPERIMENT 35.

*Fuga carabao 125.*—This animal contracted rinderpest by exposure to sick animals.

July 20, 1917, carabao 125 presented its first rise in temperature, registering, p. m., 40.4° C.

July 21, administered intravenously 2,000 cubic centimeters of sodium-chloride solution in which 12 grammes of chlorazene had been dissolved.

July 23, bloody diarrhea; N. E.; administered intravenously 1,000 cubic centimeters of sodium-chloride solution in which 6 grammes of chlorazene had been dissolved; also 1,000 cubic centimeters of sodium-chloride solution intraperitoneally in which 6 grammes of chlorazene had been dissolved.

July 24, bloody diarrhea; N. E.; animal very sick; sunken eyes; discharge from eyes and nostrils; ulcers in mouth; swallowing frequently.

July 25, D., N. E.; died during the forenoon; good lesions of rinderpest.

EXPERIMENT 36.

*Fuga bull 4310.*—This animal contracted rinderpest by contact with sick animals.

July 21, 1917, bull 4310 presented its first rise in temperature, registering, p. m., 40.2° C.

July 22, administered intravenously 2,000 cubic centimeters of sodium-chloride solution in which 9 grammes of chlorazene had been dissolved.

July 23, administered intravenously 2,000 cubic centimeters of sodium-chloride solution in which 10 grammes of chlorazene had been dissolved.

July 26, D., N. E.; administered intravenously 1,000 cubic centimeters of sodium-chloride solution in which 4 grammes of chlorazene had been dissolved.

July 27, D., N. E.

July 28, found dead in the morning; good lesions of rinderpest.

From the results obtained in experiments 29 to 36, inclusive, it will be noted that chlorazene by the method in which it was administered had no curative effect upon rinderpest.

SALICYLATE OF MERCURY.

This drug was used with the idea that it might have a specific action upon the virus of rinderpest. By hypodermic injection rapid and powerful action is obtained, free from gastro-intestinal irritation, which has to be considered when treating rinderpest.

In some of the experiments serum was used simultaneously with the salicylate of mercury to try to increase the resistance of the animals toward the disease.

### EXPERIMENT 37.

*Fuga carabao 128.*—This animal contracted rinderpest by exposure to sick animals.

July 21, 1917, carabao 128 presented its first rise in temperature, registering, p. m., 39.8° C.

July 24, D., N. E.; given a deep intramuscular injection of 0.5 gramme of salicylate of mercury suspended in 12.5 cubic centimeters of paraffine oil.

July 25, D., N. E.; given a deep intramuscular injection of 0.5 gramme of salicylate of mercury suspended in 12.5 cubic centimeters of paraffine oil.

July 26, D., N. E.; given a deep intramuscular injection of 0.5 gramme of salicylate of mercury suspended in 12.5 cubic centimeters of paraffine oil.

July 27, bloody diarrhea; N. E.; animal very sick.

July 28, found dead in the morning; good lesions of rinderpest.

### EXPERIMENT 38.

*Jolo carabao 98.*—This animal contracted rinderpest by exposure to sick animals.

July 24, 1917, carabao 98 presented its first rise in temperature, registering, a. m., 38.9° C.; p. m. 40° C.

July 25, given a deep intramuscular injection of 0.5 gramme of salicylate of mercury suspended in 12.5 cubic centimeters of sterile paraffine oil.

July 26, given a deep intramuscular injection of 0.5 gramme of salicylate of mercury suspended in 12.5 cubic centimeters of sterile peraffine oil.

July 27, a. m., diarrhea beginning; p. m., D., N. E.

July 28, D., N. E.

July 29–31, bloody diarrhea; N. E.; animal very sick.

August 1, bloody diarrhea; N. E.; sunken eyes; discharge from eyes and nostrils; grinding teeth; swallowing frequently; ulcers in mouth; arched back; straining frequently; catchy respiration.

August 2, found dead in the morning; good lesions of rinderpest.

### EXPERIMENT 39.

*(Serum and salicylate of mercury.)*

*Fuga carabao 127.*—This animal contracted rinderpest by exposure to sick animals.

July 27, 1917, carabao 127 presented its first rise in temperature, registering, a. m., 39.1° C. It was given 300 cubic centimeters of antirinderpest serum subcutaneously and intramuscularly 0.5 gramme of salicylate of mercury suspended in 12.5 cubic centimeters of sterile paraffine oil.

July 28, given a deep intramuscular injection of 0.5 gramme of salicylate of mercury suspended in 10 cubic centimeters of sterile paraffine oil.

July 29, D., N. E.; given a deep intramuscular injection of 0.5 gramme of salicylate of mercury suspended in 10 cubic centimeters of sterile paraffine oil.

July 30, D., N. E.

July 31, bloody diarrhea; N. E.; animal very sick.

August 1, bloody diarrhea; N. E.; animal very sick.

August 2, bloody diarrhea; N. E.; died during the forenoon; good lesions of rinderpest.

### EXPERIMENT 40.

(*Serum and salicylate of mercury.*)

*Batanes bull 4317.*—This animal contracted rinderpest by exposure to sick animals.

July 28, 1917, bull 4317 presented its first rise in temperature, registering, a. m., 39.2° C.; given 300 cubic centimeters of antirinderpest serum subcutaneously and 0.5 cubic centimeters of sterile paraffine oil intramuscularly.

July 29, given deep intramuscular injection of 0.5 gramme of salicylate of mercury suspended in 10 cubic centimeters of sterile paraffine oil; p. m., D., E. L.

July 30, D., N. E.

July 31, bloody diarrhea; N. E.; animal very sick.

August 1, bloody diarrhea; N. E.; animal died during the forenoon; good lesions of rinderpest.

From the results obtained in experiments 37 and 38 it will be noted that the deep intramuscular injections of salicylate of mercury had no detrimental effect upon the virus of rinderpest. From the results obtained in experiments 39 and 40 it will be noted that the combination of antirinderpest serum and salicylate of mercury had no detrimental effect upon the virus of rinderpest.

## ANTIRINDERPEST SERUM.

### EXPERIMENT 41.

*Fuga carabao 135.*—This animal contracted rinderpest by exposure to sick animals.

July 30, 1917, carabao 135 presented its first rise in temperature, registering, a. m., 38.8° C., and was injected subcutaneously with 300 cubic centimeters of antirinderpest serum.

July 31, N. E.

August 1, N. E.

August 2–3, D., N. E.

August 4, D., E. L.

August 5–6, bloody diarrhea; N. E.; animal very sick.

August 7, found dead in the morning; good lesions of rinderpest.

EXPERIMENT 42.

*Fuga carabao 134.*—This animal contracted rinderpest by exposure to sick animals.

August 10, 1917, carabao 134 presented its first rise in temperature, registering, p. m., 40.1° C.

August 11, given subcutaneously 1,000 cubic centimeters of antirinderpest serum; p. m., diarrhea starting.

August 12, D., N. E.

August 13–14, bloody diarrhea; N. E.; animal very sick.

August 15, found dead in the morning; good lesions of rinderpest.

EXPERIMENT 43.

*Fuga carabao 126.*—This animal contracted rinderpest by exposure to sick animals.

August 12, 1917, carabao 126 presented its first rise in temperature, registering, a. m., 39.4° C.; given subcutaneously 1,000 cubic centimeters of antirinderpest serum.

August 14–15, D., N. E.

August 16, D., N. E.; aborted.

August 17, bloody diarrhea; N. E.

August 18, bloody diarrhea; N. E.

August 19, bloody diarrhea; N. E.

August 20, animal found dead in the morning; good lesions of rinderpest.

From the results obtained in experiments 41 to 43, inclusive, it will be noted that antirinderpest serum had no protective effect upon the final outcome of the disease when injected in as large a dosage as 1,000 cubic centimeters.

Antirinderpest serum is more effective when used before the symptoms of rinderpest make their appearance.

It is also beneficial when administered in large quantities to animals which have a high resistance or are infected with an attenuated strain of virus. When handling animals which are

highly susceptible such as are used in the laboratory in experimental work, and when such animals are infected with a highly virulent strain of rinderpest such as is used in the laboratory in carrying on experiments, and when this type of animal presents the first symptoms of the disease, then the administration of antirinderpest serum is of no benefit as a protective or curative agent.

### CANABIS INDICA AND SERUM.

This drug was used for its antistasmodic, analgesic and narcotic action, and also to stimulate the appetite. It was thought that possibly by the action of the drug and the support it would receive from the antirinderpest serum, there might be a chance of the animal developing enough resistance to overcome the disease.

#### EXPERIMENT 44.

*Batanes bull 4313.*—This animal contracted rinderpest by exposure to sick animals.

July 31, 1917, bull 4313 presented its first rise in temperature, registering, p. m., 40.2° C.

August 1, given subcutaneously 300 cubic centimeters of antirinderpest serum and intervenously 5 cubic centimeters of fluid extract of *Canabis indica.*

August 2, administered intervenously 5 cubic centimeters of fluid extract of *Canabis indica.*

August 3, D., N. E.; administered intervenously 8 cubic centimeters of fluid extract of *Canabis indica.*

August 4, D., E. L.; administered intervenously 10 cubic centimeters of fluid extract of *Canabis indica.*

August 5, D., E. L.; administered intervenously 10 cubic centimeters of fluid extract of *Canabis indica.*

August 6, D., E. L.; blood and mucus; administered subcutaneously 10 cubic centimeters of fluid extract of *Canabis indica* and given drench of tanin solution.

August 7, D., N. E.; administered subcutaneously 10 cubic centimeters of fluid extract of *Canabis indica* and given drench of tanin solution.

August 8, found dead in the morning; good rinderpest lesions.

#### EXPERIMENT 45.

*Batanes bull 4320.*—This animal contracted rinderpest by exposure to sick animals.

August 1, 1917, bull 4320 presented its first rise in temperature, registering, p. m., 39.6° C.

August 2, injected subcutaneously 300 cubic centimeters of antirinderpest serum and intravenously 5 cubic centimeters of fluid extract of *Canabis indica.*

August 3, D., N. E.; given intravenously 5 cubic centimeters of fluid extract of *Canabis indica.*

August 4, D., E. L.; given intravenously 10 cubic centimeters of fluid extract of *Canabis indica.*

August 5, D., E. L.; given intravenously 10 cubic centimeters of fluid extract of *Canabis indica.*

August 6, D., E. L.; given intravenously 10 cubic centimeters of fluid extract of *Canabis indica.*

August 7, bloody diarrhea; N. E.; given subcutaneously 10 cubic centimeters of fluid extract of *Canabis indica* and given drench of tanin solution; animal very sick.

August 8, animal found dead in the morning; good lesions of rinderpest.

### EXPERIMENT 46.

*Fuga bull 4323.*—This animal contracted rinderpest by exposure to sick animals.

August 4, 1917, bull 4323 presented its first rise in temperature, registering, a. m., 39.2° C.

August 5, D.; administered subcutaneously 500 cubic centimeters of antirinderpest serum and intravenously 5 cubic centimeters of fluid extract of *Canabis indica.*

August 6, D., N. E.; straining; very sick; administered intravenously 10 cubic centimeters of fluid extract of *Canabis indica* and given drench of tanin solution.

August 7, bloody diarrhea; N. E.; straining; very sick; given intravenously 10 cubic centimeters of fluid extract of *Canabis indica;* given drench of tanin solution.

August 8, animal found dead in the morning; good lesions of rinderpest.

From the results obtained in experiments 44 to 46, inclusive, it will be noticed that the administration of fluid extract of *Canabis indica* and antirinderpest serum had no effect upon the final outcome of the disease. The animals used in experiments 44 and 45 continued to eat for a much longer time than is usually the case in a fatal attack of rinderpest, and in this respect the *Canabis indica* helped them. They also did not develop ulcers in their mouths until the day before death.

### MEDICINAL METHYLENE BLUE.

#### EXPERIMENT 47.

*Fuga bull 4324.*—This animal contracted rinderpest by exposure to sick animals.

August 8, 1917, bull 4324 presented its first rise in temperature, registering 39.3° C.

August 9, administered intravenously 800 cubic centimeters of sodium-chloride solution in which was dissolved 1 gramme of medicinal methylene blue (Merck); p. m., diarrhea beginning.

August 10, bloody diarrhea; N. E.; administered intravenously 500 cubic centimeters of sodium-chloride solution in which was dissolved 0.5 gramme medicinal methylene blue.

August 11, bloody diarrhea; N. E.; animal very sick; administered intravenously 500 cubic centimeters sodium-chloride solution in which was dissolved 0.8 gramme medicinal methylene blue.

August 12, animal found dead in the morning; good lesions of rinderpest.

From the results obtained in experiments 2 and 47, it will be noticed that medicinal methylene blue has apparently no detrimental effect upon the virus of rinderpest when administered either subcutaneously or intravenously.

### MISCELLANEOUS EXPERIMENTS.

The data on the following experiments cannot be located but the writer has the results of these experiments in mind.

I. During the year 1913, a small Batanes bull which was suffering from an attack of rinderpest was injected intraperitoneally with quinine sulphate which was dissolved in acidulated sodium-chloride solution. This animal recovered from the disease. Undoubtedly the animal would have made a recovery without any treatment when the results of further experiments with quinine sulphate are considered.

II. During the year 1913, two Batanes bulls suffering from rinderpest were given subcutaneous injections of camphorated oil, which is frequently prescribed as a circulatory stimulant in septicemia. Both of these animals died of rinderpest.

III. In the early part of 1914, two animals which were suffering from rinderpest were treated with fluid extract of gentian and fluid extract of *Nux vomica*. These drugs were administered with the idea of keeping the circulation and appetite toned up. Both animals died of rinderpest, the drugs having practically no effect upon them, as both animals developed inappetence and

diarrhea and died in the usual length of time noticed in severe cases of rinderpest.

IV. During the early part of 1914 a bull suffering from rinderpest was drenched with dilute alcohol administered at short intervals. This animal developed all the symptoms of rinderpest and died of that disease in the usual length of time.

V. During 1912, several animals were treated with castor oil and all of them developed the usual symptoms and lesions of rinderpest and died of that disease.

## FIELD NOTES.

Dr. Stanton Youngberg, Chief Veterinarian, Bureau of Agriculture, and the several veterinarians in charge of the immunization stations in the provinces have been using strychnine, nitroglycerin, and echinacoid, on animals which have a severe reaction while passing through the immunization. (Simultaneous method, receiving an infecting dose of V. B. and a supposedly protecting dose of antirinderpest serum on the same day or within one or two days of each other.)

These workers find that all three of the above-mentioned drugs prolong the life of animals by their stimulating effect and in many instances seem to sustain life long enough for the animal to develop sufficient antibodies to combat the disease and in this way make a recovery. They find that when using strychnine great care has to be taken in not stopping the use of the drug too suddenly as its action is very transient and if not administered at short intervals the animal is apt to suffer collapse and die suddenly.

Although these drugs are practically useless for animals which contract rinderpest in the usual way and have not previously received a protecting dose of serum, the results would indicate that they might be used on animals which have severe reactions while being immunized.

## CONCLUSIONS.

1. From the results of the 47 experiments in which drugs and serum were used in treating animals sick with rinderpest it will be noticed that but one animal, carabao 3182, experiment 20, recovered from the disease and subsequent experiments (21 to 26, inclusive) on animals treated similarly to carabao 3182, succumbed to the disease, which proves quite conclusively that carabao 3182 would have recovered as readily without any treatment.

2. From the result obtained in Number I of the miscellaneous experiments it is quite evident that this animal would have made a recovery without any treatment, when the results of experiments 7 to 10, inclusive, are considered. The animals in these experiments were treated in a similar manner and all of them succumbed to the disease.

3. It will be noticed that over fifty animals were experimented upon with the various drugs mentioned, and that but two animals recovered from the disease, which is positive proof that the drugs used and administered as they were had no curative power for an animal suffering from rinderpest.

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# CURRENT NOTES—THIRD QUARTER.

NOTES BY P. J. WESTER, Chief, Section of Horticulture.

### A POSSIBLE FACTOR IN COCONUT-BEETLE CONTROL.

In an attempt to escape or minimize the ravages of diseases and insect pests to agricultural crops the modern planter has recourse to: (*a*) The cultivation of varieties resistant to the crop pests; (*b*) the control of these pests by means of predaceous insects and fungi; (*c*) by the direct means of spraying, fumigation, traps, etc. The two first-named methods are generally regarded as the most satisfactory and the cheapest, provided that the resistant characteristics combine with other desirable qualities or the natural pest enemies are present at such a rate that natural control becomes effective.

Many of our agricultural insect pests are thus kept in check through natural agencies that render them comparatively harmless.

In many parts of the Eastern Hemisphere with the extension of the coconut industry, the coconut beetle has increased at a rate that makes it a formidable and dangerous pest and no natural enemies of this destructive insect have so far been reported. Coconut planters are therefore likely to view with more than ordinary interest the first discovery of an enemy of this beetle. The information here conveyed was given to the writer by Mr. F. Warner, of the Bureau of Education, during a recent visit to Jolo, Department of Mindanao and Sulu. According to Mr. Warner, there is in the interior of the island of Bohol a flying lemur, *Galeopithecus* sp., commonly known as caguan, which has been domesticated by the Filipinos and bred partly for the value of its skin, which is used for the making of hats, and partly for catching coconut beetles.

The caguan is said to be about 60 to 70 centimeters long, color from mouse gray to golden brown with white, irregular markings on the sides and underneath. The caguan is insectivorous and as stated is employed to catch coconut beetles. The leaves of the Jak, *Artocarpus integra,* are said to be the only herbage eaten by the animal, which is considered harmless. The flesh

is poisonous, at least to dogs, which vomit it after eating. Nothing is known of the breeding habits of the caguan.

Considering that no natural enemies of the coconut beetle have heretofore been recorded, and that because of the poisonous character of its flesh, it would be likely to have few natural enemies, if it may be multiplied rapidly and, as is reported, if it is not of a roving habit, the caguan is of no little interest and may possibly prove of value in the fight against the beetle.

### ORIGIN OF THE "MORO" CORN.

The "Moro" corn has for several years been recognized as the best all-around corn in the Philippines. Since no record thereof has appeared in print, an account of its origin and introduction into field-culture may be of interest.

Mr. John Spirig, the owner of the Patalon Plantation, Zamboanga, in 1910 planted corn as an auxiliary crop between coconuts, two varieties being employed, the Mexican June and a native white. Of these the former was found too soft to be of value and the latter was of inferior yield. The two varieties were sown side by side and hybridization took place as a matter of course in the adjoining rows. In the next planting several plants appeared that were more robust and bore larger ears than the ordinary corn, and upon ripening were found to be a satisfactory flint corn. Mr. Otto Galle, the manager of the plantation, then started systematic selection of the hybrids. The new type in its present form had become constant and was exhibited by the Moro Province at the First Philippine Exposition in Manila in 1912, where it was awarded a gold medal as the heaviest Philippine corn per measure unit and the best yielder per hectare in gross culture.

Corn of this variety was subsequently purchased in quantity from the originator by the Bureau of Agriculture and distributed throughout the Philippines under the name "Moro" corn, a name that it had inadvertently acquired as being a part of the Moro exhibit.

## NOTES BY C. W. HINES, Sugar Technologist.

### PRODUCTION OF FOOD STUFFS.

In view of the possible scarcity of many of the necessary food products consumed on sugar plantations which were heretofore imported from abroad the planters of the Archipelago have shown an inclination to produce as much of this material as possible on their own plantations. Tracts of land of the proper

character to grow the various auxiliary crops have been selected and from now on the workmen employed on the plantations will be largely fed on rice, beans, corn, and the like, produced by themselves.

### NEW USE FOR SUGAR.

A new use has been recently found for sugar by Drs. Swart and Ultee, of Java, in the curing of rubber. Heretofore acetic acid was used exclusively for that purpose but through the experiments of the above-named scientists it has been learned that sugar acts equally as well if not better than acetic acid for this purpose, and it may be employed at greatly reduced expense.

### NEW DEPOSITS OF FERTILIZER MATERIAL.

Due to the inability to secure fertilizer material by even those planters who have learned the value of fertilizer for the growing of sugar cane, extensive search has been made for deposits of bat guano in the various parts of the Archipelago. In several instances, particularly in the southern provinces of the Island of Luzon, these searches have resulted in the location of extensive guano deposits. This material, however, has invariably contained a low percentage of nitrogen which condition was due no doubt to the extremely soluble substance containing that element having leached away during the rainy seasons. Analysis of this material showed the following average result: Nitrogen 1 per cent, phosphoric anhydrid 15 per cent and potash 1 per cent.

### SUGAR SALES.

A great portion of the centrifugal sugars was moved to the American and Hongkong markets by the first available transportation after the sugar was turned out. Due to the high price paid and the steady demand for this grade of sugar the planters were eager to convert their product into money as soon as possible after it was produced. The case of low-grade muscovado sugars was somewhat discouraging, however, since these sugars are employed mainly for local consumption, except a small amount that is shipped to the Chinese coast whenever transportation is available. In consequence of the greatly increased over seas freight rate, it has been found rather unprofitable to ship products of as low a value as the poorer grades of sugar for any great distance. In a number of instances sugars testing between 80° and 85° have been sold for $2 or lower per picul ($1.40 per hundred pounds).

## SUGAR EMPLOYED IN VETERINARY SURGERY.

La Clinica Veterinaria, No. 19, pages 766–785, reports that sucrose as well as glucose has been successfully employed as a dressing in veterinary surgery. The article states that its action as an absorbent as well as an antiseptic dressing serves the purpose as well as other compounds previously used and in addition it stimulates the nutrition of the tissues and prevents all possible forms of infection.

## SEEDLING CANE.

The new varieties of cane obtained from hybrid seed collected during the past year have so far made an excellent growth and an unusually high percentage of the original plants have survived. These are being transplanted to the permanent plot and will be grown under strict observation for the first year. They will then be cut back to extend the area of each variety as soon as the stools are fully developed.

A great number of the varieties produced two years ago have made a very satisfactory growth and stooled well. It remains to be seen during the maturing season whether varieties will meet the required sucrose test and other standards demanded for a cane here.

## CANE HARVEST.

The greater part of the cane crop was harvested by the forepart of May but in a number of isolated instances where there were modern factories to handle the crop, the mills have continued grinding on cane from the more remote districts. The planters find that there is an appreciable lowering of the sucrose and purity in the cane by holding the crop until late in the season when the mills have finished their own harvests, yet the increased extraction coupled with the higher grade of product made well repays them for employing this system.

Cowpeas as a cover crop at the Lamao Experiment Station.

THE PHILIPPINE

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### SUGAR AS A FACTOR IN THE PRESENT WAR.

From present indications it is evident that sugar will play a very important part in winning the present war. As a carbohydrate food this product occupies a commanding place due to the large amount of energy which it furnishes the human system, in addition to the stimulating qualities which it possesses. So important has the Food Commission of the United States considered this product that it was one of the first articles on which was set a certain maximum price at which it might be sold. The refineries and sugar producers have also placed their entire resources at the disposal of the Government for use in any way desired.

It is said that necessity is the mother of invention and this might apply to discovery as well, for in these war times, due to the difficulty of securing various substances, new sources of supply have been discovered that were scarcely dreamed of before the times of emergency. Sugar, likewise, has occupied a place of no less importance as a source of supply for various synthetical compounds and it now plays an important part in the laboratory of the synthetical chemist.

It has been announced that glycerine is now made from sugar on a comparatively large scale in certain European countries, and this is also the case in the United States. As this chemical forms an important constituent in the manufacture of certain explosives, it is considered of great importance when it is realized that this product was very difficult to procure and the new discovery offers practically an unlimited source of supply.

While the decline of the beet-sugar industry in the various warring nations has caused a decrease in the production of sugar, from something like 17 million tons to less than 12 million tons, yet the present supply is in reality used in feeding only about three-fourths of the world's population, since only a limited amount of sugar reaches several of the belligerent countries. If only the usual demands were placed upon this product the per capita amount would not be much below that consumed in normal times. As a matter of fact, the extra demands placed upon this material for purposes other than food assists in using up the supply and materially diminishes the amount per capita.

# RURAL CREDIT IN THE PHILIPPINES.

By MACK CRETCHER, *Assistant Director.*

The remarkable growth of the coöperative idea, especially as applied to rural credit operations, has attracted world-wide attention, and is worthy of careful thought and honest effort by all progressive people. In every country in which coöperation has made progress there has been opposition and difficulties to overcome. This has been particularly true in the Philippines where farmers are isolated and established over a vast territory where means of communication are inadequate, where there is lack of a common language and where the baleful influence of usury has become an intrenched, established custom.

The urgent need of some sort of rural credit has been felt in the Philippines for many years. Working capital is essential to the agriculturist and it has been beyond the reach of the small farmers except at ruinous rates from usurers. It has been demonstrated in other lands that in union there is strength, and the desirability and necessity for the uniting of agriculturists for mutual defense against usurers and produce speculators has been recognized. In Europe the small agriculturists provided the money needed for their operations. They evolved a plan of coöperation where by joint effort they created security. This security attracted deposits and was accepted for loans of capital. Suitable rules were made by the people themselves for the conduct of their credit banking business. Reports for the year 1912 show that there were 65,000 successful coöperative peoples's banks in Europe with over five million dollars of active capital, all gathered from the people and loaned to the people without any government money or management entering into the transaction.

Realizing the importance of this wonderful record and convinced that in time and possibly in amended form it was capable of adoption in the Philippines, the first steps toward the education of the people concerning coöperation were made during the latter part of the year 1914, when a campaign was launched by the provincial government through the Bureau of Agriculture for the organization of agricultural societies throughout the

provinces. This work was so successful that early in the year 1915 provincial agricultural societies with a membership composed of leading agriculturists, had been formed in over twenty provinces, and under these parent or governing societies, branch or municipal societies were formed in nearly three hundred municipalities well distributed throughout the Archipelago, with a total membership of over twenty thousand farmers. There has been a steady growth and extension of these agricultural societies since that time. The object of this organization was that of systematic agricultural education concerning the principles of coöperation, thus paving the way for the establishment of rural credit, coöperative work-animal insurance, irrigation projects, coöperative marketing, and other enterprises of mutual or community interest.

The first definite action taken toward the establishment of rural credit in the Philippines was the enactment of Act No. 2508, known as the Rural Credit Law, by the Philippine Legislature, February 5, 1915. This act provided for the organization of associations to be denominated "Agricultural Credit Coöperative Associations," and stated that the purpose of the aforesaid associations should be to "accumulate funds, by means of coöperation, in order to extend to their members credit on reasonable terms for exclusively agricultural operations, and to encourage thrift, activity, and punctuality in meeting obligations among said members."

Although the preliminary organization leading toward coöperative effort on the part of the people had all been handled under the supervision of the Bureau of Agriculture, the control of the proposed rural credit organizations was placed in an entirely different department of the Government service, Sec. 43, of the act specifically delegating this power to the Executive Secretary. This provision was remedied by the legislature by an amendment passed February 3, 1916, which placed the administration of Act No. 2508 in the hands of the Director of Agriculture and made other minor changes in the original act. In the meantime, however, a whole year had elapsed without even one rural credit society being formed under the new law. This delay was not entirely due to the provision above stated. The people were not in a particularly receptive mood for progress along coöperative lines and additional educational work was required. Farmers the world over are conservative and slow in adopting new and untried methods, no matter how promising. There are thousands of instances that substantiate the above statement. In Ireland, under Sir Horace Plunkett, after a coöperation law

had been passed, it took fifty meetings to organize the first society. Today there are in Ireland over 100,000 farmers engaged in coöperative business transactions, the total volume of their business amounting to over fifteen million dollars annually. In France and Germany those who secured the enactment of coöperative laws discovered that the people they sought to benefit were slow in appreciating what the new legislation meant and a thorough campaign of organization and education had to be carried out before the societies were formed which became the very basis of agricultural progress in Europe. The state of Massachusetts enacted a credit union law for its farmers in 1909, and in 1911, after two years had elapsed, the committee in charge made a report deploring the fact that the provisions of the law had not been taken advantage of by the people, thus showing that agricultural legislation without proper organization and education was practically useless. This same situation is particularly true in the Philippines where "custom" is followed with almost religious tenacity, and it is therefore little wonder that progress in rural credit was slow and at times discouraging.

Having determined upon an aggressive and persistent campaign for the organization of rural credit societies, the Bureau of Agriculture took the first active step in the matter on August 25, 1916, by forming a rural credit section in the Bureau, of which Mr. A. W. Prautch was appointed chief. Mr. Prautch at once organized an office force and commenced work with vigor and enthusiasm. Plans of the campaign were perfected, tentative by-laws were drafted, forms were outlined, books, records and blanks were adopted and approved by the Director of Agriculture, a system of auditing the societies' records in conformity with the law was arranged with the Insular Auditor—a seemingly endless procession of details before actual work could begin.

The first rural credit society in the Philippine Islands organized under Act No. 2508, was perfected at Cabanatuan, Province of Nueva Ecija, October 19, 1916. Progress since that time has been quite satisfactory. At the outset, two different plans of organization were considered, one having in prospect the organization of only a limited number of societies, these to be given the most minute care and supervision at every step of their progress, thus working out surely the idea of coöperative credit in these limited instances, their labors thus becoming a successful experiment and a guide for a more extensive campaign at a later date. The other plan proposed the extension of the organization of societies as rapidly as possible

from the start. Each plan had its advantages and its unsatisfactory features. The first plan gave the thorough, careful supervision so greatly needed by a new and untried enterprise, but extended the benefits of the law to only a limited number of people. The latter plan meant a rapid extension of the idea over a large portion of the islands, but naturally precluded the possibility of careful supervision, instruction, and guidance from the Central Office, as there is a limit to the activities of a small though efficient office force. As usually results, the Office kept well on safe middle ground between these two extremes, organizing more societies than could be given personal supervision in every instance, yet not extending the organization in a haphazard, indiscriminate manner.

Thus the work has progressed very satisfactorily, so that now, one year after the organization of the first society, there is an ever-increasing demand for rural credit societies. The growth of the societies has been healthy and encouraging. The reception of the idea of rural credit has been most hearty. Provincial governors, local officials, leading farmers and prominent citizens in general, have enlisted for the rural credit campaign and have freely given their services in the work of organization.

Under Act No. 2508 all rural credit organizations must incorporate in accordance with the Philippine Incorporation Law (Act No. 1459). There must be not less than five nor more than fifteen incorporators. From these incorporators a board of five directors is selected. Twenty per cent of the capital stock must be subscribed before incorporating and 25 per cent of this subscription must be paid to the treasurer at the time of incorporation. Shares to the full amount of the capital stock may then be issued and sold. Act No. 2508 limits individuals holdings to $250, and each member of the association is limited to but one vote irrespective of the number of shares held. Par value of the shares must not exceed $2.50 each. The usual price of shares in most associations has been placed at $1, this popular price making them attractive to the man of small means. The law grants special exemptions and privileges to the associations. There are no fees or charges for incorporation and no taxes until the paid-up capital exceeds $5,000. They are also exempted from court fees payable to the Insular Government for actions brought under this Act or to enforce the payment of obligations contracted in favor of the association.

Once incorporated, the association may engage in the fol-

lowing operations: Extend credit to the members of the association for securing title to and registration of their land under Act No. 496 and for purchasing and securing title to new agricultural land; for the purchase of live stock, fertilizers, preparations for the destruction of pests of various kinds, and for the purchase of seeds, machinery, or implements which the borrower shall use for agricultural purposes exclusively; for the redemption of incumbrances on agricultural land; for the cultivation and improvement of such lands; for the expenses in connection with the planting, cultivation, harvesting or care of any agricultural crop or product, or storage and housing until sold or marketed; upon gathered products stored in a safe place and at the disposal of the association, in a sum not to exceed 50 per cent of the fair market value of such gathered products; and for the construction, repair, and maintenance of works of irrigation or drainage of land. Associations are further authorized to open credits in current account, with interest, with the members of the association; to acquire or purchase seeds, fertilizers, preparations for the destruction of pests of various kinds, machinery, live stock, and agricultural implements of any kind and sell the same to the members of the association; and lastly to contract loans and receive deposits in order to increase their working and circulating capital.

By this last clause it may be seen that it is not the intention to have the association provide all the capital, but that they shall established a security by which they may increase their working capital by securing money as loans from outside sources.

Commenting upon the operations of the rural credit law, Mr. Prautch, in one of his reports, says: "In practice the application of the machinery of this law is very simple. There is a sum of money, large or small, in the hands of the treasurer at incorporation. The amount depends largely on the confidence that has been created by those who presented the matter to the general public. The directors meet and receive applications for loans. They decide on the merits of each case. The poorest and neediest who have a legitimate productive use for the money are considered first, as the association is limited by law to one municipality. The character and reputation of each applicant is known and if he furnishes two securities to sign his note to guarantee its prompt payment, the loan is voted and the president and secretary are instructed to sign a check

for the amount on the municipal treasurer, who is by law ex officio treasurer of the association. When the funds have been loaned out and there are unsatisfied applicants for loans the directors will feel impelled to sell more shares to increase the capital stock to meet the growing needs. Each loan received by a small agriculturist is an argument among his neighbors that these associations are practical. They do not understand the system or its working but they see the real money that has been loaned at 10 per cent a year to their neighbors and they buy shares and an ever widening circle of influence is at work. Everything depends on the character, activity and public spiritedness of directors. Unfortunately there are associations in which the directors were selected by the members on their social merits, therefore the fine machine of rural credit is not working at all or on very low pressure. Even the most discouraging associations are not entirely hopeless. The visits of the agents have a helpful effect, the information of what other associations are doing acts as a stimulant, and a new election may change the board. It must always be remembered that these incorporated associations have the right to carry on their business in their own way provided they do not violate the law. Our power is merely advisory."

The law requires that sufficient security be taken for each loan. Three kinds of security are permitted, personal, chattel mortgage, and real-estate mortgage. Personal security is defined as "a bond signed by two or more persons of recognized solvency in the municipality." Associations have been advised to make only small loans of $50 or less, emphasizing the fact that a note signed by the borrower and two endorsers is good security and less troublesome than a mortgage on crops, implements, cattle, or real estate. Loans cannot be made for a longer period than one year, but they may be renewed if in the judgment of the board of directors there is valid reason for so doing. The rate of interest is limited to 10 per cent per annum. Loans may be made only to members of the associations, and every member is required to own at least one share of stock. No director is permitted to vote on a loan for himself or for any member of his family. The combined credit of the association serves as an inducement to secure deposits not only from members but from outsiders as well, thus adding a savings-bank feature and also increasing the loaning capacity and working capital of the institution. As a guarantee of safety for depositors, the law limits the amount of deposits that may be received

to a sum equal to the capital stock and by further declaring that the entire assets of the association shall be available to guarantee depositors, who shall have a prior right to said assets as against all other creditors. Provision is also made for a reserve fund which consists of a sum set aside by the board of directors from the net profits at each annual balance prior to the distribution of any dividend, said sum to be not less than 20 per cent of the net profits.

The administration and government of these associations is largely in the hands of the members, although there is Government supervision and audit and as a further measure of safety, the funds are held by the municipal treasurer, a bonded official, who is by the law made ex-officio treasurer of the association. Arrangements are made for the transaction of business at a stockholders' general assembly which shall be held at least once each year. The Insular Auditor, through his deputy, audits the association accounts at the same time the municipal funds are audited. The Director of Agriculture or his deputy examines the working of each association at least once every six months to see that the provisions of the law are being properly observed.

These associations represent a simple form of banking. When the people of a community have collected a sum of money by coöperation, they all feel a personal interest in their enterprise and watch the loans made and the security given. The utmost publicity is invited. This stimulates interest and attracts new members, thus the funds and the ability to administer them, advance together. The very struggle at the beginning, to secure funds, makes better and more self-reliant members and promises greater success than if all difficulties and obstacles had been removed by mistaken but well-meaning philanthropists.

Concerning the actual operations of the law, Mr. Prautch says: "Many of the founders of these associations are or have been members of the municipal council, so parliamentary usage and keeping the minutes and administering the affairs of the association is not unfamiliar and dozens of copies of resolutions and minutes of the meetings of the boards of directors are sent in which are entirely satisfactory and prove beyond a doubt that the plan is feasible and adaptable to the people of this Archipelago. Naturally the same degree of interest is not taken in every association nor has the same progress been made but there are encouraging features which bespeak a brighter future. It must be borne in mind that, first of all, the money belongs to the people themselves. Act No. 2508 permits and encourages them to administer their affairs and they permit only such to

join as are of good character. This feature if strictly adhered to will go a great way toward making safe and helpful loans. The board of directors carefully examines the applications for loans and if satisfied on every point the loan is granted. The man who receives the loan would not injure his chances for future loans by defaulting and compelling his bondsmen to pay. Those people are the only friends he has, as that is the world he moves in. A moment's reflection will convince one that these associations appeal to the strongest ties that human beings possess—a sense of brotherhood. They do not approach sentimentalism nor, on the other hand, are they so fiercely commercial that they cannot be helpful. Careful business rules govern all the transactions, but a man is not made to feel that he is suspected of being a swindler or thief when he applies for a loan. He feels a confidence in an institution in which he is a part owner and he will value and respect the membership more and more as his understanding of the plan and its utility is enlarged by experience and observation."

These credit associations are unquestionably training people with limited ability and small means, to grow by their own efforts. They provide a place to borrow as well as to deposit funds. They enable a person to state his financial needs to his neighbors instead of to strangers. If the association starts with only $100 capital, it is posible to make at least ten loans of $10 each, and the value of these loans to the borrowers can be appreciated only by those thoroughly familiar with usury as it is practiced in the Orient. The plan for advancement and growth is elastic and progress depends upon the coöperation of all. No better system is known to develop self-help, to enable self-respecting people to create a system of finance for themselves without asking or receiving charity or gifts. A great advancement toward the economic independence of the Filipino people will be made when the money now taken from the small agriculturist in ruinous interest, remains with him through the agency of these rural credit associations.

The movement is growing. Counting the associations that have completed their organization but have not yet incorporated owing to all the subscribed capital not having been collected, there are at present writing (October, 1917) over one hundred rural credit associations already established in the Philippine Islands, representing a combined capital stock of over $150,000, of which over $40,000 has been paid in. This is loaned out in sums ranging from $15 to $50 to small farmers for strictly agricultural purposes. In addition to this local capital, four

associations have had $500 each deposited with them to increase their working capital. Once confidence is thoroughly established, it is expected that this will be one of the best sources of obtaining sufficient working capital. As there is a constant propaganda carried on to increase the membership in each society it is hard to give accurate figures but a safe estimate places the total membership at over 20,000 people who are interested in these associations to the extent of having purchased shares. Nine associations adopted the price of $2.50 as the par value of their shares. The others have placed the value at $1 per share. Interest in rural credit is growing rapidly. One of the most hopeful features is that the people no longer depend upon the Bureau of Agriculture for the organization of associations. The governors of provinces, presidents of municipalities, senators, representatives, and public-spirited citizens in all walks of life are taking an active part in the campaign by pointing out the benefits of rural credit and explaining the plan in order to remove suspicion and prejudice. This, with the hearty indorsement by the members who have given the plan a trial, added to the cordial support of the public press, indicates that advancement in the future will be satisfactory and encouraging.

Only a start has been made it is true, but it is a start and a good one, based upon sound economic principles. The smallness of the loans and the limited capital secured may appear to be insignificant to men of large affairs, but it should be remembered that it is just such a class of small farmers, small investors, small borrowers, that this system is designed to help. Big business is reasonably well taken care of in the Philippines. There are large banking institutions that have ample facilities for taking care of a great portion of the commercial and industrial transactions of the country. In addition to these big banking institutions there is the recently organized Philippine National Bank, a Government institution with a capital of five million dollars. None of these institutions are so constituted, however, that they may render aid to the small agriculturist who is poor, has no Torrens title to land to offer as security, yet needs assistance as much as any one and heretofore has had no recourse but to fall into the clutches of the ruinous usurer, which has kept him in a condition of semiservitude. The progress made in developing rural credit may appear small, therefore, but it is reaching a class of people that can apparently be reached in no other way, and is aiding them by simply teaching them how to profitably help themselves through coöperation and mutual confidence.

# ORYCTES RHINOCEROS IN THE PHILIPPINES.

By D. B. MACKIE, *Entomologist.*

While engaged in the inspection of coconut groves to determine the distribution and prevalence of bud-rot, the idea suggested itself to the writer that this was an excellent opportunity to obtain at the same time some similar data on the rhinoceros beetle. Though the work has not yet been completed, the information resulting from these investigations is of such importance that it is considered advisable to bring it to the attention of coconut planters, to show exactly what this pest means to the planters in the Philippines, and discuss the means available for its control.

The importance of any industry and the extent to which it may require legislative control in its conservation is largely dependent upon two factors: (1) The value of the holdings; and (2) its relation to public welfare.

There are in these Islands 275,769 hectares under culture in coconut palms, and, according to statistics, 54,153,847 trees are planted. Assuming the average value of all trees, bearing or nonbearing, to be at the very least $2.50, a very conservative figure, we have the amount of $135,384,617 as the value of the holdings in this crop.

In the year 1916, despite abnormal conditions resulting from the war, the exports in coconut products reached the figure of $14,564,665, without considering the large amount of this product consumed by the domestic market.

## THE BEETLE AND ITS SIGNIFICANCE.

During a period covering almost nine years in which the writer has been directing the pest-control work of the Bureau of Agriculture, there have been received a number of complaints regarding this beetle and requests for information concerning control measures. These requests have been received with a certain degree of regularity, yet do not begin to show the widespread concern which a pest of this importance should cause.

In taking up this matter, it was early ascertained that popular knowledge of the habits and bionomics of this species were

limited to two things: (1) That the beetle kills the trees; and (2), that the immature form lives in the rotten logs and stumps of fallen trees. Also it has been demonstrated that much of the information and statistics which have heretofore been furnished by local officials is erroneous and misleading. For this reason, it has been deemed advisable to work out our own statistics.

In work of this nature, it is realized that in order to obtain data that can truly be called representative and that cannot, under any consideration, be called special, investigations must be on a sufficiently extensive scale to show the distribution and the prevalence of the beetle attacks under different environments in which coconut palms are grown. To be assured of this, surveys of districts were made to include:

1. Plantings on or near the seashore.
2. Plantings inland, from sea level to 50 feet altitude.
3. Plantings inland, on undulating land 50 to 500 feet altitude.
4. Plantings on mountain slopes from 500 feet to altitudinal limit of cultivation.

These inspections aggregated 1,134,970 trees. In district No. 1, inspections covered 91,447 trees; in district No. 2, 114,257 trees; in district No. 3, 619,511 trees; and in district No. 4, 309,755 trees. Of these, 1,036 trees in No. 1, 2,255 trees in No. 2, 5,936 trees in No. 3, and 2,968 trees in No. 4, were severely injured and would, in most cases, succumb as a direct result of attacks of this beetle. Reduced to percentages, the figures are as follows:

| | Per cent. |
|---|---|
| District No. 1 | 1.13 |
| District No. 2 | 1.09 |
| District No. 3 | 0.95 |
| District No. 4 | 0.95 |
| Average | 1.07 |

It is believed that these figures show conclusively that this species is of general distribution. Also, that regardless of the environment, the percentage of infection remains fairly constant and is not materially affected by altitude or contiguity to the sea.

For reasons which will be brought out in a discussion of control measures, it is desired to show the general distribution and extent of the different coconut holdings, both in relation to infestation by beetles and otherwise.

The following table gives data on only a part of the 1,134,970 trees inspected, but these data are sufficiently representative to be included herewith.

*Size of holdings and their percentage of beetle infestation.*

| Trees. | Owners. | Trees. | Infested. | Percentage of infestation. |
|---|---|---|---|---|
| **PLANTINGS ON OR NEAR THE SEASHORE.** | | | | |
| 1-50 | 2,208 | 50,755 | 526 | 1.03 |
| 51-100 | 472 | 33,343 | 109 | .32 |
| 101-150 | 114 | 14,098 | 114 | .80 |
| 151-200 | 37 | 6,442 | 6 | .09 |
| 201-300 | 22 | 4,958 | 7 | .14 |
| 301-500 | 7 | 2,314 | 7 | .30 |
| 501-700 | 1 | 411 | 1 | .24 |
| 701-1,000 | 2 | 1,144 | | |
| Over 1,000 | | | | |
| Total | 2,863 | 113,464 | 770 | [a]0.67 |
| **PLANTINGS INLAND, FROM SEA LEVEL TO 50 FEET ALTITUDE.** | | | | |
| 1-50 | 50 | 950 | 147 | 15.47 |
| 51-100 | 30 | 2,054 | 123 | 5.98 |
| 101-150 | 14 | 1,772 | 112 | 6.32 |
| 151-200 | 14 | 2,429 | 88 | 3.61 |
| 201-300 | 6 | 1,442 | 57 | 3.95 |
| 301-500 | 6 | 2,235 | 287 | 12.84 |
| 501-700 | 4 | 2,577 | 130 | 5.04 |
| 701-1,000 | 1 | 708 | 30 | 4.23 |
| Over 1,000 | | | | |
| Total | 125 | 14,167 | 974 | [a]6.16 |
| **PLANTINGS INLAND, ON UNDULATING LAND 50 TO 500 FEET ALTITUDE.** | | | | |
| 1-50 | 128 | 3,319 | 159 | 4.79 |
| 51-100 | 77 | 4,512 | 438 | 9.70 |
| 101-150 | 30 | 3,681 | 196 | 5.32 |
| 151-200 | 27 | 3,718 | 101 | 2.71 |
| 201-300 | 14 | 3,248 | 86 | 2.64 |
| 301-500 | 8 | 3,042 | 301 | 9.89 |
| 501-700 | 16 | 8,602 | 161 | 1.87 |
| 701-1,000 | 10 | 6,139 | 36 | .58 |
| Over 1,000 | 5 | 7,525 | 5 | .06 |
| Total | 315 | 43,786 | 1,483 | [a]3.38 |
| **PLANTINGS ON MOUNTAIN SLOPES FROM 500 FEET TO ALTITUDINAL LIMIT OF CULTIVATION.** | | | | |
| 1-50 | 78 | 2,369 | 104 | 4.39 |
| 51-100 | 47 | 2,458 | 115 | 4.67 |
| 101-150 | 16 | 1,909 | 84 | 4.40 |
| 151-200 | 7 | 1,289 | 13 | 1.08 |
| 201-300 | 8 | 1,806 | 29 | 1.60 |
| 301-500 | 2 | 708 | 34 | 4.80 |
| 501-700 | | | | |
| 701-1,000 | | | | |
| Over 1,000 | 1 | 1,809 | 16 | .88 |
| Totals | 159 | 12,348 | 395 | [a]3.11 |
| Grand total | 3,462 | 183,765 | 3,622 | [a]1.97 |

[a] Average.

The data given in the following table were taken from an inspection of trees other than the 1,134,970 previously mentioned.

*Tabulation showing distribution of holdings and number of owners.*

| Trees. | Owners. | Total trees. |
|---|---|---|
| 1-50 | 8,314 | 205,375 |
| 51-100 | 3,741 | 273,876 |
| 101-150 | 1,440 | 179,756 |
| 151-200 | 664 | 116,506 |
| 201-300 | 574 | 140,569 |
| 301-400 | 216 | 76,708 |
| 401-500 | 104 | 47,890 |
| 501-700 | 102 | 63,718 |
| 701-1,000 | 55 | 50,706 |
| 1,001-1,500 | 25 | 34,247 |
| 1,501-2,000 | 6 | 10,815 |
| 2,001-3,000 | 2 | 4,910 |
| Over 3,000 | 2 | 10,401 |
| Total | 15,245 | 1,215,476 |

It will be seen that the percentage of infestation is much higher among the small holdings than among the extensive holdings. In a measure, this is to be expected and can be readily explained as follows: (1) Where the holdings are large, coconut culture is the major and not the subordinate pursuit, hence the trees are generally given better care as the forces are better organized. (2) Where the holdings are small, the crop owners generally are forced to work in some other way to obtain their livelihood, cannot give due consideration to their trees, and do not, as a rule, appreciate the necessity of keeping their groves clean.

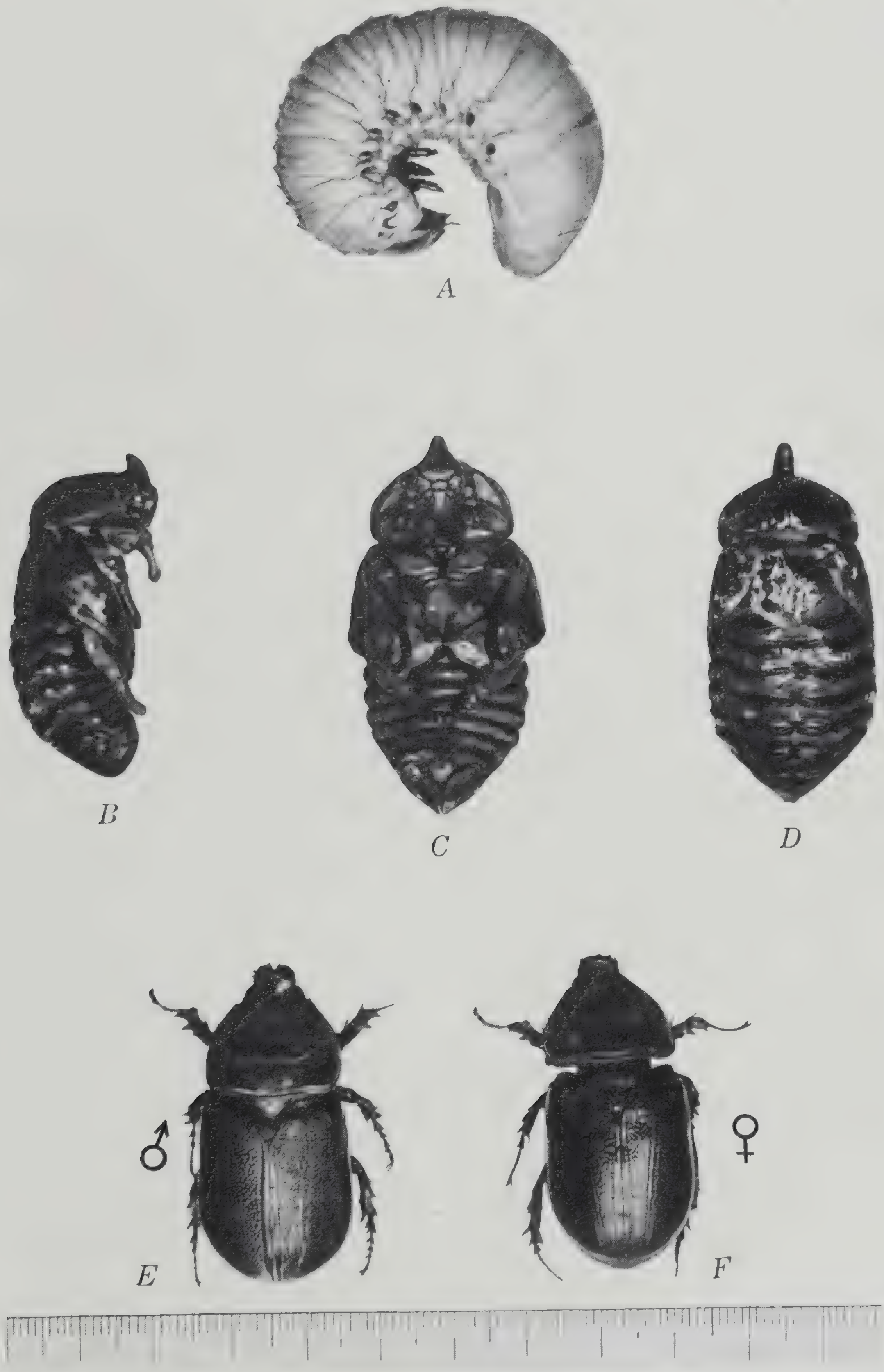
The above statements show wherein the source of the trouble lies. The next problem is to show the extent of damage caused.

Turning to our figures on infestation, we see that out of 1,134,970 trees, 12,195 succumb annually to the attacks of this pest. This is 1.07 per cent of the whole.

In order to be able to state with more accuracy the amount of damage caused, a rough count has been kept of the trees, dividing them into two groups, bearing and nonbearing, the later group including those trees that are under bearing age. In this count we find that 7,573 trees, or 0.627 per cent, are in bearing, while 4,602 trees, or 0.405 per cent, have not yet attained the bearing age.

Bearing trees, as distinct from nonbearing, are valued at from \$5 to \$7.50 each and generally bring this price or more when sold. Taking the lesser value as the average for all trees, which is deemed conservative, the monetary loss to the owners of these 1,134,970 trees is approximately \$60,975 annually.

Available statistics (which have been found to be from 10 to 30 per cent below the actual count) show a total of 54,153,847 trees in the Philippine Islands. With the percentage of infesta-




Life history of *Oryctes* rhinoceros: (A) Larva; (B) Pupa, side view; (C) pupa, ventral view; (D) pupa, dorsal view; (E) Adult male; (F) Adult female.

tion remaining the same, on this basis we would have throughout the Archipelago an annual loss of 579,446 trees traceable to this pest.

With the same values prevailing, these trees, providing they were not injured from other causes, are worth $5 each. Thus we would have an annual loss, in the tree values alone, throughout the Archipelago of $2,897,230, due solely to the attacks of this one species.

## BIONOMICS.

Under this heading is included the life history of the species. Until this part of the problem is completely worked out and clearly known, we cannot possibly tell when, where, or how to strike it at its weakest point.

### LIFE HISTORY.

[Plate II.]

*Eggs.*—The eggs, which are elliptical, measure, just before hatching, 4 millimeters by 3.2 millimeters. They are yellowish white, the shell being translucent and smooth. They are laid singly in numbers from 1 to 2 up to 18 or 20. They are not all laid in one cluth as with some insects, this function being extended over a considerable area. This is shown by the finding of both undeveloped and mature eggs in the ovaries and passages. The exact limit attained in this function is not known. Specimens kept in captivity have laid as high as 23 eggs. It is doubtful if the number ever exceeds 30.

The eggs are laid in some protected site wherever a sufficient supply of suitable food will be ready for the consumption of the newly emerging larvæ. These sites vary, as the species feeds on almost any kind of decaying vegetable matter. Only one consideration in this connection seems to influence females and that is that the locality must not be too wet. When placed in sites which are too wet, it has been noted that the eggs are attacked and are killed by a mold growth. There seem to be four preferred locations, which are, dead coconut logs and stumps, (Plate III) under bagasse heaps, in manure heaps, and in old rotten piles of coconut husks. There are other sites, such as the decayed heads of half-dead trees injured as a result of beetle attack, etc., but it is in the four places named above that perhaps over 90 per cent of the beetles breed.

These eggs hatch in 10 to 12 days. All eggs from the same

clutch appear to require the same period of incubation, as the following tabulation will show:

| Laid. | | Hatched. | |
|---|---|---|---|
| | *Number.* | | *Number.* |
| April 29 | 23 | May 10 | 23 |
| Do | 8 | May 12 | 8 |

*Larvæ.*—The young grubs which emerge are yellowish white in color and quite hairy. They commence feeding almost immediately. They remain in this state 130 to 155 days. Specimens reared in experimental work show the following larval stage:

| *Hatched.* | *Pupated.* |
|---|---|
| March 10. | August 5. |
| March 12. | August 7. |

The grubs grow fast and soon become large and fleshy and of a dirty-white color. During this stage they change their skin four times. They are provided with powerful jaws and when they are located in the dead coconut logs gnaw through the tough fiber making quite extensive galleries. They do not move far from where they are born as their power of locomotion is limited. In this stage they are blind. While there seems to be no particular seasonal brood, as eggs and larvæ of all stages may be found in the same log, yet there seems to be a larger number of adults flying about during August and September.

As has been said, decayed logs and stumps of coconut palms are preferred breeding sites. Some idea of the numbers which are reared in this environment may be had when we find that 10 stumps held 486 grubs of this species of all sizes. Ten fallen trunks of palms yielded 872 specimens. Six bagasse heaps yielded as follows:

| | |
|---|---|
| No. 1 | 86 |
| No. 2 | 98 |
| No. 3 | 17 |
| No. 4 | 56 |
| No. 5 | 70 |
| No. 6 | 82 |
| Total | 409 |

Bagasse heaps become infested according to the length of time they are left standing. Where they are allowed to stand from one milling season to another they are sure to furnish a large quota. Grubs are found in the closely packed material near the bottom where there is sufficient, but not too much, moisture. Where there are many of these heaps, the beetles become a constant menace to all palms in that vicinity.

Grove showing dead palms and old stumps where Rhinoceros beetles breed.

Next in order are the heaps of coconut husks that are allowed to collect wherever copra is made. The beetles are hardly as numerous here as in the bagasse heaps, yet they constitute a greater menace, as they are usually in close proximity to the groves. A heap of husks near a large "tapajan" outfit yielded 164 grubs of this species.

Manure heaps, while furnishing a constant menace to palm culture, do not exert a great influence in the coconut groves, as there are few of them near or in the groves. However, where coconut palms are used as ornamentals in towns, manure heaps form a most prolific source of beetles. In these places the beetles propagate in large numbers. An examination of one such heap disclosed an average of 27 grubs to each square foot of area investigated. Another location at Cavite where the stable manure was buried yielded over 42 to a like area.

*Pupa.*—The next stage in the development of the beetle is the pupa. As the time comes for the grub to undergo the changes incident to this stage it ceases feeding and hollows out a suitable chamber and prepares for its transformation. Before this takes place, it shrinks and loses its grub-like form and much of its color. The larval skin splits down the back and shrivels up. During this state it remains quiescent and eats nothing.

The resulting pupa in no way resembles its former self, having lost its grub-like appearance, and shows all the external characters of the beetle. It is light redish brown covered with a very short pubescense, which gives it a soft velvety luster. A peculiarity of this stage is the series of slits located on the dorsal region of the abdomen. These are perhaps supplementary respiratory organs. When the pupa is handled, its often emits a series of stridulations similar to those produced by certain of the adult borer beetles (*Cerambycidae*). This stage, according to our finding, lasts from 30 to 37 days, specimens pupating as follows:

August 10, emerged September 15.

It is a peculiar fact that seven adults emerging from the same clutch of eggs completed each transformation the same day and emerged as adults on the same date. Emerging adults remained in their burrows for 24 hours, evidently waiting for the hardening of the different integuments, after which they worked their way to the surface.

*Adults.*—This new stage marks the beginning of the beetle's

career as a pest. Hitherto its operations have attracted little attention, its position having been entirely that of a scavenger.

In determining just what part of the beetle's life is spent in the adult stage, we have to rely largely on those specimens that have been kept in captivity. The limit reached was 85 days; others lived 70, 55, 28, 25 days, respectively, being some that were reared from the egg.

*Description.*—Individual beetles are subject to considerable variation in size, this difference being, in general, independent of geographical distribution over large areas, yet sometimes noticeable within restricted areas. This variation is peculiar to both sexes.

Most planters are so familiar with this pest that any lengthy description would be superfluous. To those who are not familiar with it, a glance at the plate will serve to render its future identification a simple matter.

In general, they are a very dark brown, almost black and lighter beneath. The full-grown insects vary from 34 to 48 millimeters in length. A striking feature about this species is the horn located on the top of the head to which it owes its popular name, "Rhinoceros" beetle.

While the males are generally the larger and are supposed to have a longer horn, this latter character does not always hold good. A better sex index is the growth of bristles which occurs on the ventral surfaces of the posterior segments of the abdomen.

Adult beetles are most averse to light and if we would find them during day time, we must look in some dark hole or crevice. When such hiding places are not obtainable and a beetle has been overtaken by day light, it will not hesitate to burrow into the earth and will be found to a depth of 4 to 6 inches, in fact, one can be found almost any day by digging up the garden wherever the soft earth affords a convenient refuge. When the sun goes down they come out in the open and the droning buzz of their heavy flight may be heard. They are greatly attracted by light, a tendency which often leads to their downful.

*Feeding habits.*—As we examine into its feeding habits, it is found that its attacks are not confined to the coconut alone. This is important, as it may materially affect any control measures that are directed against it. With equal avidity it feeds on the buri, *Coryphaelata Merrill,* the fish-tail palm, *Caryota urens,* the West Indian Royal palm, *Oreodoxa regia,* and the African oil-nut palm, *Elaeis guineensis,* and several

other palms. It is likewise said that the sugar palm, *Arrenga saccharifera,* is attacked, though to date palms of this species have never been noted as damaged by it.

Having located a convenient coconut palm the beetle maneuvers till it finds a suitable location near the base of the petiole of the central unexpended leaves, a place it invariably selects with almost unerring precision. This place being located, operations are immediately commenced. With its sharp, serrated teeth it separates the fibers of the leaf by an up-and-down motion and soon works its way into the interior. From the time the burrow is deep enough to admit of its using the spurs on the fore legs, progress is rapid, work being facilitated by the fact that the inner tissue is softer and the fiber less tough. As it works, it feeds on the soft tissues by sucking their juices. By means of its legs and head the burrow is cleared out, large amounts of fine fiber being discharged, some of which sticks around the entrance and some of which falls to the ground and is a good indication of the presence of the beetle. The hole thus made often reaches a depth of 30 centimeters. In this hole the night is spent and often the next day also, though not often longer. It is this peculiarity of habit that makes the beetle so destructive to all palm trees belonging in that botanical group which grow by the accretions to stem, which take place within the part already formed. All coconut palms have only one central bud or growing point. As this bud is in direct alignment with the beetle tunnel, it often happens that it is cut into and so injured that the bud dies.

In cases where this fatal injury is inflicted, the softer tissues die first. The dying spreads slowly outward and progresses with decreasing rapidity as it encounters the harder fibrous tissue of the older fronds. Often these trees will continue to try to develop fruits twelve months after they are attacked. In fact, it is an expected thing for a tree fatally injured to develop blossoms, an example of the working of that biological law relating to the perpetuation of species which causes a plant seriously injured to attempt to reproduce itself. It is also one of the things that is often misunderstood, giving rise to the belief that the tree is still thrifty and in a healthty condition. Continued observation will show the fallacy of this popular belief, as it will be noted that the tree has been shocked to such an extent that the added drain on its powers of recuperation are so great and its vitality so reduced that it is unable to continue growth or develop nuts. A large number of young nuts drop,

and the few that may reach maturity are small and in every way subnormal. The handling of such injured trees will be discussed in another paragraph.

From the fact that the beetle takes only a matter of some hours to enter and in some cases to fatally injure a palm tree, some idea of the extent of the injuries which it may inflict during this period may be derived.

It is important that the planter be able to determine when a tree is injured beyond the possibility of recovery. This is a matter in which the individual tree may be subject to considerable variation. There are trees which have the apical bud destroyed and do not send out a new frond. When there is no central frond, the plant's doom is sealed. The "die back" will extend laterally, the oldest fronds being the last to die. There are also trees in which the bud is injured but not killed outright. Such plants are often able to continue growing, sometimes for a year, before they finally succumb. There is one means by which it is often possible to get direct evidence as to the state of the crown without climbing or cutting it open. The fronds nearest the center should be carefully examined. If they get smaller as they approach the center, that is, shorter than the laterals, it is evident that the vitality of the tree is declining, and that it will sooner or later succumb to its injury. It may send out flowering stems, but the growth made by the central frond should be the index by which the tree is judged.

Experiments have shown that where coconut trees are severely injured by beetles, it is good practice to pull off all fruits and allow no flower spikes to develop beyond the falling of the staminate blossoms. At this time the pistillate blossoms which resemble small nuts and are as yet unfertilized may be readily seen and removed. Such procedure will often save the life of a tree that would otherwise succumb as a result of the added drain upon its vitality by reason of its effort to produce fruit when all of this vitality was needed to bring about its healthy recovery from injury

A good example of the benefits to be derived from this procedure was furnished during an investigation of the results of defoliation and injury of coconut palms by locusts. In these investigations, conducted at Compostilla, Cebu, two groups each of six palms were almost completely defoliated, the fronds being badly broken by the weight of locusts which alighted on them. At the time of injury they were with nuts and blossoms. In group 1, both nuts and blossoms were stripped off and none

(a) Coconut tree showing repeated attacks of Rhinoceros beetles.

(b) Dead palms are favorite breeding places for Rhinoceros bettles.

allowed to develop; in group 2, the trees were allowed to recover as best they might.

There was no opportunity to visit these trees until six months after the date of their injury (August, 1912). January 1, 1913, it was observed that all trees in group 1 had made a healthy recovery while five of those of group 2 were dead.

It is considered conservative to conclude that 40 per cent of the trees that die as a result of beetle attacks might be saved by this treatment, yet planters in general fail to understand its value and seldom, if ever, apply it. (Plate IV, *a.*)

Having shown the life cycle and the feeding habits the next point is to consider such factors as have influenced the present situation.

It is well known, in the process of nature, that forces have a tendency to balance each other so that none gains such ascendency as to crowd out or completely overpower another.

Perhaps the most important of the laws dealing with this subject is the one commonly stated in this way, "No form of life can multiply beyond its food supply." The truth of this is obvious, but it is often overlooked. Thus as the area devoted to the culture of certain plants has been increased, the food supply of such insects as live upon these plants has also been increased, and under the improved conditions there will result a far greater increase in the number of insects than the increase in the areas devoted to the crops.

We find in the case of the species under consideration that insects often pass readily from a wild plant to a cultivated one. Again, in the absence of cultivated plants, they are able to sustain themselves on wild plants.

As we review the life history of this species it is seen that one thing stands out most prominently which most graphically depicts the case in question, namely, that the favorable environment which allows it to propagate and become such a pest is due almost entirely to the activities of man. Some of these are, leaving the husks of coconuts in piles, or leaving bagasse in heaps, etc.

The influence of lack of clean culture on this species is clearly shown by the outbreak which occurred in the Island of Leyte in 1915. During this year, the office of pest control was the recipient of many letters reporting that extensive and unprecedented damage was being done to the coconut groves of that district by this beetle. An investigation was made, and the following are the facts:

The above-mentioned district was in the direct path of a typhoon which swept that island in November, 1912. As a consequence large numbers of coconut palms were either blown down or had their tops blown off. These were allowed to remain and no atempt was made to destroy them. By the beginning of 1914 the trees were soft enough to allow the beetle to propagate therein. In this favorable environment they developed in enormous numbers and the trees that had escaped the typhoon were nearly all killed by the beetles.

The next thing to consider is the natural influences which act as a check on the propagation of the beetle. It becomes necesary to study them in order to know their possibilities in connection with control measures. Though our investigations along these lines have been comparatively extensive, the findings are largely negative. Taken in their order they are, (1) natural enemies, (2) diseases, (3) floods and drought. Under the first of this group, as natural enemies, are insectivorous mammals, reptiles, etc., in fact all members of the animal kingdom that either prey upon or are parasitic on the beetles. Examinations show that a few species will feed upon the beetle, but the beetle's habits render it comparatively immune to attack from this source. Separating these predators into those which feed on the larvæ and those that attack the adults, we find as follows:

Rats of the genus *Epimys* which are generally found in most groves often make their nests in the fallen log stumps, etc. One species in particular, a large gray rat, *E. mindanaensis*, is very common. This species eats quite a number of grubs and it is very possible that they eat the adult also when such are available. This rat is an unmitigated pest of other agricultural crops, however, and deserves no protection because of killing a few grubs.

Of the avian enemies, there are virtually none that feed upon it except casually. Domestic fowls will eat the grubs that happen to be exposed in cleaning up the bagasse or manure heaps, as will the common crow, *Corone filipina*. Lizards also may kill a few.

Those species which are predators on the adult are likewise few, mainly because of the beetle keeping in hiding in the day time. In only one instance have the remains of adult beetles been found in the stomach of a bird, which was a specimen of the common roller, *Eurystomus orientalis*, taken about 6 p. m.

Parasites are also few. The only species which has been noted that could be termed parasitic is a small mite that exists as an ecto-parasite. It does not, however, seem to affect the beetle's transformations in any way, though present on it during

the larval, pupal, and adult stages. A large Scoliad wasp has been reported as parasitic on the grubs but to date it has never been observed at this function.

In connection with diseases, while perhaps not strictly proper to include under disease the fungus parasites yet they are popularly called as such. Under this head is found a very interesting entomogenous fungus which when conditions are right is able to develop in the larvæ. Material of this species was taken in considerable quantity to German Samoa, by Dr. Freederichs, Director of Agriculture of that country, in an endeavor to control the beetle in that group of islands where it had recently been introduced. It was identified by him as *Mettarhizium anisoplæ Metch.* Since its discovery as a parasite on larvæ of this beetle, it has been noted that it is quite a common species in this Archipelago and is found growing on the larvæ of several other kinds of beetles. It is liberally distributed in some parts of Tayabas Province and will undoubtedly be found in others.

When conditions are favorable for the development of this fungus considerable numbers of larvæ are killed by it and in connection with control measures, it might be of certain value, as simple experiments made with it show that its action is comparatively rapid.

Experiment 1: February 2, eight full-fed, healthy larvæ secured from a manure heap were placed in boxes containing some material on which they were feeding. On this material was shaken spores of the fungi on February 27. The first larva successfully completed its transformation. By March 1, all eight had successfully pupated. On March 10, there was decided evidence of infection by the fungus. On March 14, all were dead.

Experiment 2: Group 2 consisted of 10 three-fourths grown larvæ placed in a box on March 17 with one of the dead pupa from experiment 1. They were all dead on April 8. On April 16, the fungus was producing spores.

Experiment 3: On March 17, ten larvæ were placed in a jar with horse manure in which was placed one infected larva. On March 29, the first one succumbed and by April 6, all were dead.

Before taking up control measures, it may be well to give some of the general methods, by which insect pests are controlled.

The basic principles governing methods of controlling insect injuries are the same the world over and may be grouped under four general classifications: (1) Agricultural methods; (2) mechanical methods; (3) the use of natural enemies; and (4) insecticidal methods.

The principal agricultural method by which the injuries of noxious insects may be prevented is clean culture. There is probably no one general method by which planters can do more to protect their crops from insect injuries than this. A large proportion of injurious insects pass certain stages of their lives in rubbish of some sort, the burning of which would lead to their destruction, and if such rubbish is not allowed to accumulate, danger from the pest is lessened. This clean culture also reduces the opportunity for feeding and breeding and enables us to adopt with greater certainty of success other methods of destruction.

In studying the case of the larva, we find this method adaptable. The insect finds a suitable feeding ground during this stage in the rubbish and is thereby enabled to propagate and become distributed.

In seeking a method of control we find two separate sets of feeding habits, each radically different from the other: (1) The habits of the adult; (2) the habits of the larvæ. In discussing the former stage we find that remedial measures are impractical as the injury is not apparent until it is too late to save the palm. The habits of the adult, especially its nocturnal feeding habits, render it difficult to apprehend. Its methods of operation make such remedies as poison ineffective, because of the fact that the beetle does not feed till the heart of the tree is reached. It is also found that the point of the attack is one that is subject to constant change. It has not yet been proved practicable to protect the trees by bands or covering of any kind to keep off the beetle. In fact, as our knowledge of its habits during this stage increases, it is more firmly believed that it cannot be materially reduced in numbers by attacking it during this stage.

In studing the larval stage, we have found (1) that about 80 per cent of the individuals that damage the groves propagate in refuse heaps and in dead coconut logs, in or about the groves, and in materials that are useless to man and the destruction of which is beneficial to him; also, that the beetle spends all parts of the life cycle except the adult stage in such locations; (2) by gathering and burning these logs we not only kill all the immature beetles therein but deprive the adult beetles of suitable breeding sites.

Th next problem is how to take advantages of this predilection for trash heaps, decaying logs, etc., to destroy the pest. We find that such places are a necessity to the beetle for laying

eggs and to furnish the requisite subsistence during the larval stage. As the available breeding sites are reduced larger numbers resort to those that are left. In this way it will readily be seen that the remaining beetles will come to all such places as furnish them suitable sites for this function.

This is, of course assuming that the groves are generally kept clean of fallen logs, stumps, and other breeding sites, otherwise, there being a sufficiency of such places, there will not occur any necessity of the beetles seeking the trap pits. (Plate IV, *b*.)

Applying this theory, it is found that compost pits constructed in suitable locations attract large numbers of beetles and they deposit their eggs therein. These trap pits can be cleaned out periodically and the grubs easily destroyed.

The question naturally arises as to how often it becomes necessary to do this cleaning. Here our knowledge of the life history of the species becomes useful. It has been demonstrated that the entire life cycle, with the exception of the adult stage, is spent in these masses of rubbish, thus giving us a period of $12+155+35=202$ days during which the pest will remain in the trap pits. Thus it will be seen that if these traps are cleaned out once in 6 months, the progeny of all the beetles that have laid eggs there during the period will still be there, and a large part can be destroyed.

In cleaning the pits, if the six-months period is adhered to, it will be necessary to make the work more thorough and secure all of the small grubs, as otherwise they will have attained the adult stage before the next cleaning date arrives. If the period between this operation is shortened, the necessity of getting all of the small ones and eggs is eliminated.

Generally speaking, insecticidal methods cover anything which is utilized to destroy insects. For convenience they are usually divided into three groups, which include:

(1) That group which is used to kill the insect by poisoning its food supply, such as stomach poisons.

(2) That group that kills by the insecticide being drawn into the respiratory system, thus killing by its effect on the respiratory organs, such as fumigants.

(3) That group which kills by contact either through its caustic action on the skin or by closing up the breathing pores.

In relation to each method the first thing to be considered is naturally the methods applicable to the species, and, secondly, whether it is applicable to the conditions obtaining in this

country. Under class 1, that of poisoning the food supply, our investigations show that in a degree this is feasible and offers a means of reducing the numbers. We know that the larval stage of the beetle is spent in the decaying stumps, which are porous and spongy. Therefore, if by any means these stumps could be soaked with poison anything feeding on them would be killed. Experiments show that these stumps will, when dry, readily absorb any liquid and that they are easily impregnated with a poison solution by the simple means of boring a hole or holes into them with a large auger, and filling these holes with the solution.

The water then evaporates allowing the poison to remain, thus killing anything that feeds on the poisoned wood. Fallen logs can also be thus treated. We know that arsenate of soda at the rate of 1 pound to 40 gallons of water will kill this species in any stage. By this means, we are able to poison almost permanently these sources of food supply.

Poisons in proportion, such as are mentioned above, are fatal in from four to thirty-six hours, according to the amount consumed, to any insects that feed upon them.

While it is possible to make traps out of stumps, etc., we find that the application of this method, in a measure, is not well adapted to the conditions under which coconut culture is practised in the Islands for the reason that the groves are mostly small holdings and the people are not familiar with the handling of poisons and cannot be relied upon to carry out the work, which would in turn involve the Government's aid to assure success. Its application would required treating all logs, stumps and trash heaps in the groves and would tend to discourage better cultural methods by leaving these logs and stumps.

Assuming that by clean culture and the burning of all fallen logs, stumps, etc., the injury resulting from this species can largely be prevented, the next question is how this shall be accomplished. In considering this phase of our problem, it would seem that three alternatives present themselves. These are: (1) To advise the planters of the means at hand for controlling the beetle and leave its control in their hands; (2) to have the local government units promulgate ordinances making the cleaning up of groves compulsory and leave the enforcement in their hands; (3) to invoke the provisions of Act No. 2515 and prescribe an Insular ordinance making the cleaning up of groves compulsory and providing for Insular inspection to coöperate directly with the planters in their work.

In any of these measures, the fact must not be lost sight of

that the work to be effective must be thorough, as nearly simultaneous as possible, and kept up.

No. 1. provides for the leaving of the work in the hands of the planters. This measure offers the following disadvantages: It leaves the application of the remedy in the hands of persons who do not realize the value of such measures and consequently cannot be relied upon to carry them out. Also, there are always the lazy who will not take the trouble to do their work properly and whose lands will become the centers of distribution, and thus a lack of general knowledge of the work will lead progressive owners to mistrust the value of the method.

In discussing the second method, an excellent example of the risk which may be anticipated in leaving the application of control measures to persons untrained in this branch of agriculture, is shown by the experience of a certain town in the Visayan Islands. Owing to the disastrous typhoon of November, 1912, which swept through the northern Visayas and devastated a wide belt, a large portion of the coconut trees in the above-mentioned municipality were uprooted or had their tops blown off. A year later these dead trees became decayed to such extent that they furnished breeding sites for large numbers of rhinoceros beetles. The municipal council most opportunely passed an ordinace requiring property holders to clean up their lands, granting a year and half for the work.

The owners, some through lack of means, others by reason of having to seek employment elsewhere, and others through negligence, allowed the time to pass without complying with the ordinance.

As a result the beetles have propagated and have now become an unmitigated pest which threatens to destroy the remainder of the groves if not checked.

It will thus be seen that while regulations were prescribed they were not enforced, and the results threaten to become disastrous to the coconut industry in that town.

In connection with an Insular ordinance for work of this nature, we find that section 2 of Act No. 2515 provides as follows:

"The Director of Agriculture shall, subject to the approval of the Secretary of Agriculture and Natural Resources, make and enforce such rules and regulations as he may deem necessary to protect the agricultural interests in any district infested or infected with any injurious or dangerous plant pest or disease which may heretofore have become established or which hereafter is liable to become a menace to said interests."

By virtue of this Act, authority is vested in the Director of Agriculture to prescribe and enforce such regulations as work of this nature would call for.

The great value which a central power would have in combating a pest of this nature must be conceded. In this way the same laws become applicable to all towns and provinces, while the evil of the pest being allowed to mature by reason of failure on the part of officials or planters in one district or town to appreciate its significance and allow it to reinfest plantations that have been kept clean by hard and conscientious work will be largely corrected.

*Cost of campaign.*—In estimating the costs of a campaign of this nature there are two things which must govern operations: (1) It must be on a scale to guarantee a more or less simultaneous action throughout the field of operation; (2) when a regulation is brought into force its enforcement must be carried out without fear or favor. These being assured, next comes the actual working plans of the campaign. These are, first, to ascertain the areas planted to coconuts; second, to ascertain their natural topographical boundaries and areas of haviest infestations; third, to divide these districts into lesser districts according to their topography, cultural areas, population, transportation facilities, etc.; fourth, to ascertain the ownership of groves; fifth, to determine the location of holdings; and sixth, to ascertain the number of trees per owner.

Next will come the placing of the forces.

In this, the inspectors would act as supervisors in actual work and assist and coöperate with the owners in their work.

In the matter of equipment it has been found by experience that much time will be saved and undue labor avoided by the Government providing its inspectors with certain necessary equipment such as axes, chains, etc., for assisting in hauling out logs, stumps, etc., to sites where they may be burned without injury to standing trees. In this case the owners of the groves would of course supply the labor and carabaos.

As to the amount of land that can be cleaned per day per inspector, this would of course be governed by two factors: (1) The General condition of the groves; and (2) the coöperations furnished by the planters. The inspection work conducted incident to budrot control has furnished much valuable data on which to base such estimates. From these data it would seem that in the coconut belt of Luzon one inspector provided with the proposed equipment (3 axes, 1 crosscut saw, 1 short chain tackle for pulling logs) would be able to clear off the fallen

coconut logs and stumps from three hectares of land per day. This estimate, of course, is subject to variation, according to the amount of assistance in labor furnished by the planters.

*Plan of campaign.*—In the actual campaign, there will first come the educational propaganda carried on in each municipality this to consist of lectures, illustrated by lantern slides, together with an explanation of the ordinance and the remedy it seeks. This will bring to the knowledge of the planters the existence of the ordinance and educate the owners with regard to its benefits. Experience in budrot work, where over 15,000 trees have been cut down without a single complaint, has demonstrated the benefit of such procedure. After this the district inspector will interview each planter and ascertain the number of laborers he has available and will assign them to the work. Following this, equipment for such force as may be necessary will be brought to the holding in question and the work will be done.

In favor of Government control of this work the following evidence may be presented: The coconut holdings of the Philippines, taken at the very low figure of $5 per tree for all trees, represents an investment of $135,384,617. The loss in actual trees from this beetle is nearly $3,000,000 annually. This represents an annual loss of more than 1 per cent of the entire crop, and includes only those trees which are killed and takes no notice of those that are merely injured and which recover. These, it is estimated, easily equal five times the number that are killed. No account is taken of the decreased vitality and lessened productive ability of this great number.

A campaign such as has been outlined, if properly carried out, would prevent at least 80 per cent of this loss and would save to the coconut planters of the Philippines more than $2,000,000 annually. To this would be added the not inconsiderable item of the increased value of the groves, due to the increased productivity.

Last, but not least, comes the educational value of such a campaign. This cannot be figured in dollars and cents and is little understood by the average person; yet every campaign of this nature which brings to the attention of planters the value of protective measures, in turn reflects itself in increased self-reliance and ability in handling such matters and makes for a better understanding between the people and the Government in agricultural matters and also helps them to appreciate improved methods in agriculture.

*Conclusion.*—It has been shown that by an actual count of

individual trees over a large area, there is an annual mortality of over 1 per cent of the trees, directly traceable to this beetle; the distribution of the pest is general; its presence in numbers of injurious abundance is due to lack of proper cultural methods; this 1 per cent loss represents only the trees killed or fatally injured and does not take into consideration the crop losses due to temporary injuries: planters themselves do not appreciate the extent of this damage and cannot be relied on to carry out control measures.

To attain success, the matter must be taken up under governmental supervision and conducted systematically by forces trained and familiar with this line of work. The loss sustained to the coconut planters by trees killed is nearly $3,000,000, and 80 per cent of this loss is preventable by simple control methods.

# IMPORTANT ROOT CROPS OF THE PHILIPPINES.

By F. C. KINGMAN, *Chief, Agronomy Section,* and E. D. DORYLAND, *Station Superintendent.*

The place that root crops hold in the agricultural scheme of the Philippines, entitles them to marked consideration when discussing the food-production possibilities of the Archipelago. Root crops of the sorts mentioned in this paper are to be found abundantly, or at least well established, in practically all parts of the Islands, and are growing at practically any period of the year; thus they furnish a constant supply of nourishing food the year around. The majority of these crops do not constitute a regular field crop except in a few localities, but find their place as secondary crops to fill in after the main crops have been removed. There are no available data on the amount of food produced from these plants, but without these crops, the importation of food into the Islands that would be necessary, would be limited only by the amount of available steamship tonnage calling at Manila and other island ports. It is with this idea in mind that the following papers have been prepared.

## ZINGIBER OFFICINALE.

Ginger, like a good many other of the minor Philippine crops, has the prospects of a good commercial future if the industry can be given anywhere near a fair chance for expansion and development, as the plant produces a good crop of excellent-quality "roots" (plate V, *a*), used wholly for domestic purposes at present. The dried rhizomes bring a good price on the provincial market and there is no apparent reason why the industry should not be encouraged. The yield of freshly dug roots, when the plant is given even moderately good care, is between 12,000 and 18,000 kilos per hectare. In drying the roots loose about 70 per cent of their weight and then contain about 10 per cent of water. The plants are propagated from pieces of roots and are planted in rows 50 to 75 centimeters apart. Of the 60 species of the genus Zingiber found from Tropical Asia to New Guinea, 5 are grown in the Philippines although some of them are imperfectly known. (Merrill, Flora of Manila.) The plant is widely distributed throughout the Islands having been introduced into the Philippines as into all other

tropical countries where it is grown, from India, its probable native home.

The common names used for ginger in the Philipines other than the English form ginger, are: Jengibre, Spanish; Luy-a, Visayan; and Luya, Tagalog. The portion of the plant which makes it of commercial value is the more or less aromatic root stalk (rhizomes) in which the spicy portion of the plant is most concentrated.

There are two principal kinds of ginger as prepared for the markets, namely, coated or uncoated, and scraped. The latter is prepared by removing the epidermis when freshly gathered and is sold as white ginger. Candied and preserved gingers are prepared in China and put upon the market as such, and usually command a good price. The well-known ginger ale is an extract from dried ginger root, made up with water, sugar, lemon juices, and yeast.

Ginger is also used to a limited extent in medicines but its principal uses are as food delicacies and this is the market to which the producer must cater.

### ARROWROOT.

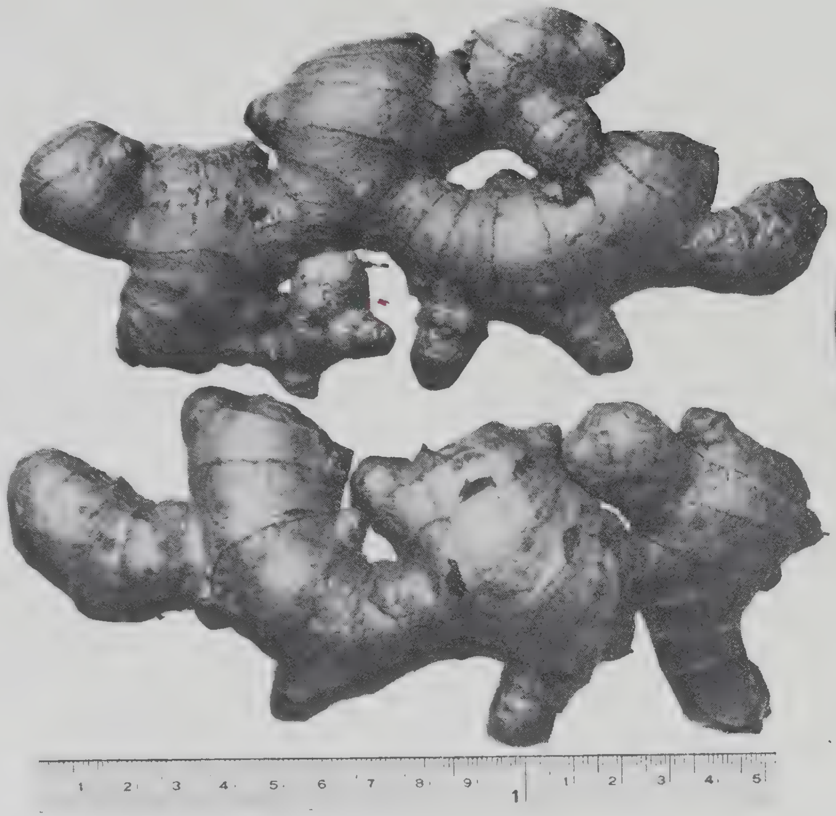
The underground parts of a number of different plants grown in tropical and subtropical countries are used to manufacture the product commercially known as arrowrot.

The true arrowroot, *Maranta arundinacea,* is the plant most commonly cultivated for this purpose in South Africa and the East Indies. It is much grown in the Bermuda Islands and, therefore, is commonly known as Bermuda arrowroot.

The other plants which furnish a source of arrowroot starch are *Maranta nobilis, Manihot utilissima* (cassava), several species of Canna, *Canna achiras, C. edulis, C. flaccida, C. indica,* and *Tacca pinnatifida.*

Both the marantas and the cannas have fleshy rhizomes, while the cassava and the tacca have fleshy roots resembling sweet potatoes.

Although all the above-named plants, with the exception of *Maranta nobilis* and *Canna achiras,* are found in the Philippines, only two, *Maranta arundinacea* and *Tacca pinnatifida,* are used to any extent in the manufacture of arrowroot starch. The *Maranta arundinacea* is an erect, glabrous, dichotomously branched, perennial herb attaining a height of from one-half to one meter. It was introduced into the Philippines from tropical America at an early date and is now cultivated to a small extent and occasionally occurs spontaneously.



PHILIPPINE ROOT CROPS.

(*a*) Typical rhizomes of ginger, *Zingiber officinale*, as grown in the Philippines.

(*b*) Tubers of sincamas, *Pachyrrhizus erosus*, about eight months old.

The plant is propagated from its fleshy, fusiform rootstocks which are divided and planted in rows about 1 meter apart and 30 centimeters apart in the row. The tubers may be harvested about 8 to 12 months from the time of planting and under favorable conditions should yield 10 metric tons of roots per hectare.

Although no figures as to the starch content of Philippine-grown tubers are available, analyses made of tubers grown in other countries indicate that the starch content is about 25 per cent. However, owing to the crude processes of manufacture usually employed it is seldom that more than 15 per cent of starch is recovered, which would give about 1,500 kilos of prepared arrowroot per hectare.

Tacca, *T. pinnatifida,* is a stemless herbaceous plant, native of Ceylon and the Pacific Islands and is commonly known as the Polynesian arrowroot. It is widely distributed throughout the Philippines, occurs growing wild in thickets, mainly near the seashore, and is cultivated to a limited extent. The plant is propagated by the division of the roots and is planted in the same manner as the true arrowroot, *Maranta arundinacea.* A scape of small greenish flowers is developed at maturity and potato-like tuberous roots, which yield a starch equal to that of the true arrowroot. The tubers are usually dug after the leaves fall.

From whatever source the arrowroot may be derived the process of manufacture is practically the same. The fresh roots are thoroughly washed and then pounded or grated to a fine pulp. The pulp is diluted with water and repeatedly strained, again diluted and allowed to settle to remove all fibrous material and also to extract the coloring matter and a bitter poisonous principle (prussic acid) which is more or less prominent in all the roots used in the manufacture of the starch.

After the pulp has been washed a number of times, the water is drawn off and the pasty starch is then taken out of the tubs or vats and put on trays with coarse cloth bottoms to drain and dry. The drying process is usually effected in the sun and requires about three or four days, but the hotter the sun or the drier the air and the more quickly the product is desiccated, the whiter it will be in color and the better in quality. After it is dried the starch is in cakes and before using it is pounded or ground fine like flour.

Arrowroot flour is used in much the same way as cassava flour in the preparation of all sorts of cakes. Arrowroot starch is considered to be very easily digested and is generally recom-

mended for invalids who have found difficulty in digesting starch from potatoes and other plants. Dissolved and injected with laudanum it is sometimes used as a specific for extreme cases of dysentery.

## MANIHOT UTILISSIMA.

Cassava, *Manihot utilissima,* or as it is known throughout the Philippines, "Camoting cahoy" (sweet potato tree), is a perennial shrub belonging to the botanical family Euphorbiaceae.

This family includes, among other useful plants, the castor bean, *Ricinus communis,* to which the growing cassava plant bears a close resemblance, and several sources of commercial rubbers, such as the Para. The genus Manihot itself includes ceara rubber and several other species which seem likely to prove useful in the same way.

It is probable that, as is true of some other cultivated plants, the cultivated cassava has several wild ancestor species. While two species have been described as the original types of the cultivated forms of cassava, (1) the "bitter," *Manihot utilissima* Pohl., containing a considerable quantity of hydrocyanic acid, and (2) the "sweet," *Manihot aipi* Pohl., containing little of the poisonous acid, comparatively recent investigation indicate that all the cultivated forms have been developed from a single stock, probably the *M. aipi.*

There are a great many varieties known in cultivation. In Brazil more than fifty varieties are distinguished, most of which are bitter. In some parts of India as many as twenty-four varieties are recognized and at least four each are known in Ceylon and Madagascar. The United States has at least four generally recognized varieties and a considerable number have been imported from Porto Rico and elsewhere, to be tested.

There are no named varieties distinguished in the Philippines, but a considerable difference is recognized in the amount of poison, hydrocyanic acid, that is contained in the roots from different plants. Thus the so-called "sweet" and "bitter" varieties come by their names.

Cassava is very old in cultivation and is probably a native of tropical America where it was a staple cultivated crop at the time that country was discovered by Europeans. From tropical America it was taken to Africa and probably to the Far East by the Portuguese. Within the last generation or two cassava has come into fairly general use by the natives of Hawaii, and has taken the name of "pia," which to the older inhabitants meant arrowroot. There is no record as to when cassava was

introduced into the Philippines, but it is in common use and widely destributed throughout the Archipelago, though the industry is not established on a commercial basis.

Although cassava is a hardy plant which is adapted to successful growth in the Tropics under varying conditions of climate and soil, and will grow and succeed fairly well under conditions of neglect, it does on the other hand respond to good soil conditions and proper care and attention. For its best growth cassava prefers a rich, fairly deep and open soil. However, since very rich soils are often compact and heavy and undrained, and since the tolerance of cassava to drought makes it thrive better than most cultivated plants on sandy soils, these soils are in many places regarded as especially favorable to it. The roots do not endure standing water in the ground around them; low heavy soils should therefore be drained or avoided.

Aside from the fact that it must be warm, casava is very modest in its demands upon the climate. Never is it seriously injured by any drought occurring in these Islands and it is likewise not hurt by heavy rainfall, unless it grows in heavy and undrained soil.

Although the cassava plant does sometimes produce seed and may be propagated from them, the best and most practicable way is to propagate the plant by means of stem cuttings. Only sound cuttings, 20 to 30 centimeters in length, selected from sound, vigorous plants, should be used.

Depending upon local conditions it is generally considered good practice to plow and harrow the land before setting out the cuttings. The usual planting distances are to place the cuttings 1 meter apart each way, which gives 10,000 plants to one hectare of land.

If a short-lived catch crop, such as cowpeas, *Vigna unguiculata,* mungos, *Phaseolus* sp., or some other legume is interplanted, a more ample spacing between the rows, one way at least, is recommended. Under such conditions a good spacing would be, rows, 1.5 meters apart, plants 1 meter apart in the row.

The cuttings should be placed obliquely in the soil at an angle of about 45 degrees. For a month or so after the cuttings are planted they need plenty of water and for this reason planting during the rainy season is recommended. After the cuttings have started to grow and have thoroughly established themselves only an occasional rain is necessary to promote a most thrifty growth and the production of succulent roots. Roots used for food have a better texture in wet seasons than in dry.

Dry weather, however, never kills cassava, and rarely, if ever, comes near stopping its growth.

If some legume such as mungo is interplanted with cassava, several cultivations will be necessary within the first two months. After the legume is removed, the ground should be cleaned and cultivated at least once, but after the cassava plants are 4 to 4½ months old, they will require no further attention.

At the base of the stem is a cluster of long, fleshy roots, which is the valuable part of the plant. All parts of the plant contain a poisonous milky juice. The poison contained in this juice is hydrocyanic (prussic) acid.

Some varieties contain very little of this poison and are called "sweet;" others contain more and are called "bitter." The poison is completely removed by perfect washing or drying of the ground roots, by roasting, or by long boiling. The roots are ready to be used for human food at any time after they are 5 to 6 months old. Sometimes all the roots of a plant are taken at once, sometimes they are dug one at a time. In these young roots the percentage of sugar is probably as great as it ever becomes, but they are relatively weak in starch, and less woody than the older ones.

The roots of the Philippine varieties are generally best suited for direct use as human food when they are not more than nine months old. There are exceptions to this rule, however, as in some parts of the Philippines the roots are grated and eaten when three years or more old.

Under ordinary conditions in the Philippines, a conservative estimate of the yield per hectare of merchantable roots from plants one year or more old is 25 tons.

Average roots contain 25 to 30 per cent of starch, about 80 per cent of which is secured in the process of modern manufacture.

The enemies of cassava are few in the Philippines. Old roots left in the ground are often chambered or consumed by insects, but young fresh roots are never attacked. No disease of cassava is known in the Philippines. Its most dangerous enemy here is the wild hog. These animals do considerable damage when they get access to the cassava, but they of course can be kept out of the field by good fencing.

The cassava plant is useful in a variety of ways, but the roots, of course, are the most important and most valuable part of the plant.

The roots of some of the sweet varieties are sometimes eaten raw, and when either boiled or roasted the roots of both "sweet"

and "bitter" varieties are used as an article of human food. The meal is prepared in various ways. Practically everywhere in the Philippines the roots are first crushed by pounding, rasping, or between rollers. The resulting pulp after the juice is squeezed out is dried, grated and is then known as cassava flour. Cassava starch can be made use of in the preparation of all kinds of cakes just as flour or the common starches. It gives then a particularly agreeable flavor and greatly increases their hygienic and nutritive properties. Prepared with boiled milk, cassava starch is highly digestible and is to be particularly recommended as a food for young children.

Tapioca, while not a commercial product in the Philippines, is made from cassava starch by sqeezing, rolling or shaking the moist starch into round pellets, commonly done by forcing them through a colander onto a piece of shaken canvas. The pellets are then rolled or fall upon an iron plate or table, which is also shaken, and the temperature of which is about 100° C. The heat causes a partial conversion of the starch into sugar, and makes the pellets swell somewhat and become gelatinous in appearance. Depending upon the size of the pellets different trade names such as "Pearl tapioc," "Seed tapioc," "bulled heart," etc., have been given the product. "Flaked tapioc" is heated and changed in composition in the same way, without being previously put in the pellet form. Tapioc is a large export of Brazil and the Straits Settlements.

## PACHYRRHIZUS EROSUS.

*Pachyrrhizus erosus* (L.) Urb., or Sincamas, as it is known in the Philippines, is a rather coarse, scandent herbaceous vine belonging to the Leguminoseae family.

The sincamas is a native of tropical America but is now widely distributed throughout the Tropics. In the Philippines it is thoroughly naturalized and is of common occurrence growing wild in thickets and in out-of-the-way places. It is also quite extensively cultivated in certain sections of the Islands and is a popular food with the Filipinos. The root (Plate V, *b*), which is the edible part of the plant, is quite often eaten raw or is cooked by boiling, mashed, and eaten like the turnip. The root is also used in making salads.

The plant is propagated from seed which are borne in flat pods about 10 centimeters long, 10 to 12 centimeters wide, and containing from 8 to 10 seeds each.

Although the sincamas is a hardy plant and grows wild in some parts of the Islands it does nevertheless respond to good

treatment and cultivation. When grown under conditions of neglect the roots are generally small, tough, fibrous, and lacking in flavor. The cultivated plant produces a larger root of good flavor, somewhat sweet and practically without fiber.

In order to obtain a maximum crop of the best quality, the land previous to planting sincamas should be quite thoroughly prepared. An ordinary sandy loam soil, not too rich in organic matter, should be selected and after clearing the land of underbrush, cogon grass (*Imperata cylindrica*), or other growth that may be present, it should be plowed and harrowed.

The native method of planting is practically the same as for cowpeas, *Vigna unguiculata*. The rows are spaced about 60 centimeters apart and the seed scattered sparsely by hand in the furrow allowing from 15 to 20 seeds to the linear meter. If there is a high germination of seed and the resulting plants stand too close together some of them may be thinned out later on as the roots begin to develop and crowd each other. In this way a more or less continuous supply of roots is available, extending over a considerable period of time. Of course the size of the roots will depend upon their age.

For the best results, both from a quality and quantity stand point of the roots produced, the plants should receive at least two cultivations. Shortly after the seeds have germinated and as soon as the young plants define the row the first cultivation should be made. About two or three weeks later, or sooner if necessary, a second cultivation may be given. After the plants have become thoroughly established they are able to take care of themselves and no further attention need be given them.

As grown in the Philippines the sincamas is seldom allowed to attain full maturity, which usually takes about 2 years, as the roots then are exceptionally large, tough and fibrous. For this reason the roots are harvested when about 5 or 6 months of age and at this stage of growth are about the size of a turnip or smaller and are exceptionally tender and well flavored.

There are no authentic data on the yield of roots per hectare in the Philippines, but basing an estimate on the amount of roots harvested at the age of 6 months a conservative figure would be about 15 metric tons.

As is true of a number of other crops in the Philippines, the sincamas is not produced on a large scale on a commercial basis but its cultivation is confined mainly to comparatively small and scattered areas. However, the sincamas is quite an important article of diet of the Filipinos in certain sections of the Islands, and while its actual food value is, of course, not great

PHILIPPINE ROOT CROPS.

(*a*) Gabi, *Colocasia* species, growing under field conditions, Singalong Experiment Station. The vines growing on bamboo poles in the background are those of the yam family, discussed in this article.

(*b*) *Colocasia* species, showing typical corms.

the roots are very much relished and help to add variety to the usual rice and fish diet.

## COLOCASIA Sp.

[Plate VI.]

The common elephant-ear plant, used in the United States to give a tropical effect in landscape gardening, belongs to the *Colocasia* genus, a root-bearing food plant, a staple article of diet throughout tropical Asia, Polynesia, and Malaya. There are 6 or 7 species in tropical Asia to Polynesia and one in the Philippines (Merrill, Flora of Manila). In the Philippine Islands the plant, *Colocasia esculentum,* is known as gabi (Tagalog), while to the outside world it and its relatives are known as taro and cocco. The portion of the plant used for food is the sessiled, starchy, acrid stalk or corm. When prepared for food it is sometimes cleaned under water to prevent an itching sensation of the hands; boiling readily removes the acrid constituent. The tops of some varieties, however, are sometimes used as greens for cooking purposes. The Bureau of Agriculture had in past years a collection of 21 species and varieties most of which were discarded as they were very subject to fungus attacks which greatly hinders their usefulness. In the Philippine Islands the gabi is usually planted in rows and cultivation is carried on similar to potato culture in the United States. From 5 to 10 months are required for the plants to mature depending upon the varieties. The plant is usually raised in low moist land and gives fair returns for the labor expended. The market price in Manila is on an average about $1 per cavan (50 cents gold per bushel); 50 cavans per hectare is a fair yield. The Bureau of Agriculture has not encouraged the growing of gabi because of the productivity of other crops such as sweet potatoes that can be raised more readily and give far greater returns per hectare. Nevertheless the crop is quite prevalent throughout the Islands as a secondary crop.

## IPOMOEA BATATAS.

The sweet potato is one of the principal food crops of the Philippines and was introduced into the Islands by the early Spaniards from America, its indigenous home. The plant has no native names although it has been grown abundantly in every province of the Archipelago for centuries. It is known by the old Mexican name of "camote," a name introduced with the plant centuries ago. A peculiarity of sweet potatoes as grown in the Tropics (especially some of the native varieties) as compared with those grown in temperate climates, is the frequency of

the occurrence of the flowering habit. Under normal Philippine conditions a field of nearly mature camotes have an appearance not unlike that of morning glory beds; however, few of these blossoms develop fertile seeds. There are a number of good-producing native varieties, but they all lack the productivity and flavor of the best American sorts. Of the latter there are three principal kinds, the New Jersey yellow, known locally as Momungan (Plate VII *a*), the New Jersey red (Plate VII *b*), and the California large white. The New Jersey red variety perhaps holds the known record in the Islands for production, having yielded under irrigation 32,240 kilos per hectare (572.3 bushels of 50 pounds each, per acre).

There have been several other American varieties introduced into the Islands, but most of these have failed to become properly acclimated and have been discarded. One variety recently introduced from Java gives promise of becoming a good yielder, though the potatoes are small.

METHODS OF PROPAGATION.

Sweet potatoes may be conveniently propagated by the following methods: Vine cuttings, potato slips, and by planting small pieces of potatoes directly in the field. This latter method, however, is not used in the Philippine Islands as the pieces of potatoes when so planted, serve only as harbors for fungi and insect pests that not only destroy the small pieces so planted but in turn devote their ravenous activities to the coming crop. Fields planted by this method have yielded nothing but barren vines.

Vine cuttings is the common method of propagation in the Philippines. In making these cuttings, pieces of vines 15 to 20 centimeters long are used. It has been found that young vines make better cuttings than the old, where the soil is at all lacking in an adequate water supply. All leaves are removed from the cuttings before planting, as they eventually die if allowed to remain on, and also reduced the vitality of the cuttings by transpiration.

Slips are obtained by planting whole, or half, potatoes in propagation beds and covering them with soil 3 to 5 centimeters deep. Sandy soils are preferable for this purpose. The beds are kept well watered, but not muddy, as too much water causes premature decay, especially under tropical conditions. After the lapse of several days, if the conditions are favorable, young plants are produced from the potatoes and when the plants have attained a height of 10 to 15 centimeters they are pulled off and planted directly in the field. It is not necessary,

SWEET POTATOES.

(*a*) Type of American sweet potato, New Jersey yellow, as grown in the Philippines. This type is known locally as "Momungan."

(*b*) Type of American sweet potato as grown in the Philippines; New Jersey red variety, sometimes called "morado" by Filipinos. This kind grows to extreme sizes, not uncommonly weighing 4.5 kilos. Such potatoes are nonfibrous, nonpithy, and are of excellent flavor.

nor it is considered advisable, to remove the leaves from these plants, as is done with the vine cuttings, since the slips when ready to plant have roots sufficiently developed for functioning, and the leaves soon begin to play their part in plant growth.

Sweet-potato cuttings may be kept in excellent condition for a considerable length of time, by keeping them packed in moist (not wet) sphagnum moss. When so packed the cuttings will root heavily at each node and are in splendid condition for growth when planted in the field. Quite naturally, of course, if kept too long under these conditions the vitality of the cuttings is reduced.

### PLANTING.

The slips or cuttings are planted in the center of the ridges, putting them about 10 centimeters below the soil surface, or are doubled in the center leaving both ends protuding through the soil. If slips or cuttings of American varieties are used the plants are spaced 40 to 50 centimeters apart in the row, and if native varieties, 30 to 40 centimeters distance usually suffices for the best results. If irrigation water is available, 40 centimeters distance between plants will give the greater returns. With American varieties, however, if comparatively dry conditions prevail, 50 centimeters is the logical distance to plant.

For native varieties 30 to 40 centimeters between plants is the best distance to be employed, depending of course upon which of the above conditions prevail. The most ideal time for planting sweet potatoes in the Philippines is during the latter part of the rainy season. If planted at this time the last several rains enable the plants to form a good mat before the dry season sets in. Sweet potatoes may be grown with good success during the dry season provided, however, irrigation water is judiciously applied.

Experiments at Singalong experiment station have definitely proved that flat-ground planting should not be used, as the production from such planting is low (average production less than 10,000 kilograms per hectare) and the product has an unshapely appearance somewhat resembling large turnips, such characteristic necessarily giving a bad marketability.

### CULTIVATION.

Cultivation is started before the vines begin to run, that is, before they have covered the tops of the ridges. This operation is performed with a five-tooth cultivator by removing all shovels with the exception of the rear two and breaking down about one-fourth to one-third of each ridge by drawing the

cultivator between each two rows. This operation is usually followed by hoeing, for when the ridges are narrowed by cultivation, the hoeing that is necessary is materially reduced. After the completion of the hoeing the ridges can easily be thrown back to their normal position with a lister or plow, a lister being preferable.

It is scarcely necessary to repeat cultivation more than once or twice as the vines make such a rapid growth that they soon cover the ground and crowd out grasses and other weeds.

### DISEASES AND INSECT PESTS.

As no economic crop can be successfully grown without a thorough knowledge of how to combat its fungous, bacterial and insect enemies, when such are prevalent, and as the Philippines abound with such pests it will perhaps be well to mention herewith some of the more pronounced sweet-potato enemies. A fairly comprehensive description of these with possible means of control follows:

#### DISEASES.

*Mosaic disease.*—Some of the varieties of sweet potatoes in the Philippines, more commonly the American varieties and especially the Momungan variety, are subject to the mosaic disease. This malady seems to be controlled, however, by using cuttings from plants that appear to be resistant to this ailment.

Mosaic disease is considered to be a physiological derangement, which prevents rapidity in cell division in certain portions of the plant, causing stunted, distorted, unproductive plants with mosaic leaves, hence its name.

*Rots.*—Storage rots are alarmingly common among stored or crated sweet potatoes in the Philippines. Although infection usually takes place from fungus "spores" in the field, yet rough handling can be blamed for a good share of the losses incurred, as the bruises caused from handling furnish ideal gateways of infection. Consequently, great care in packing should be practised. This precaution combined with the proper rotation of crops, due care in the selection of cuttings and potatoes for "slips," together with the precaution of burning all roots and vine refuse, will aid materially in the control of these diseases.

#### INSECT PESTS.

The most noticeable and decidedly the most injurious sweet-potato pest, with which the people of the Philippines have to contend, is the *Cylas formicarius* Fabr. (plate VIII), a camote


Longitudinal section of native sweet potato, showing devastating work of the sweet potato weevil, *Cylas formicarius*. This pest is quite prevalent throughout the oriental sweet potato districts, and drastic measures are sometimes necessary to keep it under control. Note the four specimens of weevil in center of photograph. No. 1, larval stage, Nos. 2 and 3, pupa stage, and No. 4, adult stage.

or sweet-potato weevil common in Momungan,[1] Mindanao and Central Luzon, P. I., Queensland, Australia,[2] and in the sweet-potato districts of the United States.[3]

*Cylas formicarius* is a small bluish insect less than 5 millimeters in length, which deposits its eggs in recesses at the base of the vine or at the upper end of the root. The maggots bore into the roots and when in sufficient numbers, completely riddle the potatoes, reducing them to a mass of soggy cellulose tissue. The insect pupates within the root and in due time is ready to infest another crop unless radical means are taken for its destruction.

This pest does no serious damage in the vicinity of Manila, if the crop is dug early, but otherwise it is tremendously destructive. Control measures consist of early harvest, rotation of crops, and the burning of all root refuse.

### DIOSCOREACEAE FAMILY.

(*Genus dioscorea.*)

In this family there are 9 genera and about 225 species, all of wide tropical distribution. There are two genera and 18 or more species in the Philippines (Merrill, Flora of Manila). In 1912, the Bureau of Agriculture completed a collection of 116 species and varieties, divided as follows: *D. alata,* 6; *D. aculeata,* 3; *D. bulbifera,* 1; *D. daemona,* 1; and listed as Dioscorea species, 105. This collection was gathered from all parts of the Tropics, some of them being of the wild or uncultivated sorts. After these plants had been grown for a number of years, those that survived acclimation, 96 in number, were subjected to a complete chemical analysis, and an eating and growing test, with the result that all but 34 were discarded as not adapted to Philippine conditions. Those reserved are represented as follows: *D. fasciculata,* 10; *Dioscorea* sp., 18; *D. daemona,* 1; *D. alata,* 4; and *D. aculeata,* 1. Those discarded contained poisonous substances, excessive fiber and produced poorly. The ones reserved are now being propagated for distribution purposes at the Lamao station, Lamao, Bataan.

In the Philippines the importance of the yam as a food crop is not fully appreciated because of the presence of other more easily grown roots, and lack of a sufficiently dense population.

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[1] Observations at Singalong, Manila, and on products from Momungan, Mindanao.

[2] From Handbook of Destructive Insects of Victoria, Australia, by C. French, F. E. S., Government entomologist.

[3] Cyclopedia of American Agriculture, L. H. Bailey.

As economic conditions become more acute, the yam will perhaps come more into prominence as a field crop. *D. fasciculata* (plate IX, *a*) is found growing in the wild state in thickets throughout the uncultivated lands of the Archipelago. This particular plant is known as Tuñgó, Tugué, and Tamís by the Tagalog, Ilocano and Visayan peoples respectively, which, because of the variety of names or variation from a common name by long usage, shows its indigenous character or ancient introduction.

*D. alata* (plate IX, *b*) is known to the same three peoples as Ubi, thus giving an indication of the introduction of the plant from outside sources, most likely through the Tagalog country.

Cultivation is usually practised as follows: Tubers or crowns of tubers are planted from ¾ to one meter apart, in rows 1 meter apart; after the plants start growth, trellises are erected, usually of bamboo, to support the large twining vines and bring them into the open so they can properly function. From seven to nine months time is usually required for maturity. The yield of yams per hectare is approximately equal to or a little above that of the best camote varieties; however, there are some of the larger varieties that yield nearly 50 metric tons per hectare but they grow so deep that there is considerable difficulty in harvesting. Consequently they are not likely to become overly popular.

The following table gives a fair idea of the chemical composition of the several sorts of yams mentioned in this article:

*Analyses of yams, Bureau of Science, Manila, P. I., 1915.*

| No. | Remarks. | Weight. | Moisture. | Ether extract. | Sucrose. | Reducing sugars. | Protein. | Ash. | Starch. | Crude fiber. | Undetermined. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Gms.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* |
| 1 | *D. alata* | 585 | 67.53 | 0.19 | 0.34 | 0.40 | 2.22 | 0.94 | 22.82 | 0.94 | 4.62 | 100.00 |
| 2 | *D.* sp. | 430 | 68.39 | .07 | .17 | .24 | 2.99 | 1.09 | 23.42 | .65 | 2.98 | 100.00 |
| 3 | do | 880 | 67.14 | .28 | .33 | .38 | 1.54 | 1.03 | 20.79 | 1.23 | 7.28 | 100.00 |
| 4 | *D. alata* | 1,410 | 70.62 | .04 | .40 | .53 | 1.43 | 1.13 | 24.55 | .66 | .64 | 100.00 |
| 5 | do | 1,715 | 71.83 | .07 | .33 | .48 | 1.84 | .95 | 18.18 | .78 | 5.54 | 100.00 |
| 6 | *D.* sp. | 640 | 67.05 | .12 | .41 | .47 | 3.34 | .78 | 20.79 | .82 | 6.22 | 100.00 |
| 7 | do | 510 | 66.19 | .14 | .33 | .42 | 3.00 | 1.00 | 23.94 | 1.00 | 8.98 | 100.00 |
| 8 | do | 465 | 67.13 | .29 | .32 | .38 | 2.07 | .98 | 21.73 | 1.35 | 5.75 | 100.00 |
| 9 | do | 240 | 70.39 | .21 | .50 | .89 | 1.09 | .89 | 22.10 | .60 | 3.33 | 100.00 |
| 10 | do | 310 | 72.41 | .10 | .33 | .32 | 2.00 | 1.37 | 18.54 | .73 | 4.20 | 100.00 |
| 11 | do | 1,420 | 68.56 | .14 | .49 | .56 | 2.43 | .85 | 21.96 | .95 | 4.06 | 100.00 |
| 12 | do | 1,090 | 72.44 | .22 | .33 | .40 | 2.52 | .76 | 19.39 | .55 | 3.39 | 100.00 |
| 13 | do | 1,360 | 68.76 | .21 | .33 | .38 | 2.59 | .88 | 20.79 | .69 | 3.37 | 100.00 |
| 14 | *D. aculeata* | 1,460 | 71.85 | .21 | .50 | .63 | 1.37 | .67 | 19.08 | .58 | 3.11 | 100.00 |
| 15 | *D.* sp. | 580 | 73.00 | 1.23 | .41 | .51 | 3.41 | .71 | 18.99 | .46 | 1.28 | 100.00 |
| 16 | *D.* sp. (poison) | 450 | 75.10 | 1.59 | .50 | .40 | .71 | .96 | 17.33 | .54 | 2.87 | 100.00 |
| 17 | *D.* sp. | 680 | 71.84 | .14 | .49 | .40 | 1.54 | 1.18 | 20.48 | .67 | 3.26 | 100.00 |
| 18 | do | 430 | 69.13 | .49 | .17 | .21 | 1.13 | 1.42 | 20.70 | .82 | 5.93 | 100.00 |
| 19 | *D. alata* | 210 | 67.00 | .32 | .33 | .46 | 1.63 | 1.12 | 22.82 | .77 | 5.55 | 100.00 |
| 20 | *D.* sp. (poison) | 300 | 73.63 | 1.26 | .50 | .58 | 2.40 | .86 | 19.19 | .63 | .95 | 100.00 |
| 21 | *D.* sp. | 490 | 68.62 | .49 | .50 | .57 | 1.92 | .62 | 19.49 | .94 | 6.85 | 100.00 |
| 22 | *D.* sp. (poison) | 290 | 74.23 | .33 | .33 | .45 | 1.41 | .81 | 18.59 | .52 | 3.33 | 100.00 |
| 23 | *D.* sp. | 500 | 65.97 | .45 | .33 | .40 | 2.09 | .84 | 24.75 | 1.45 | 3.72 | 100.00 |
| 24 | do | 470 | 75.33 | .70 | .33 | .38 | 2.81 | 1.34 | 17.06 | .42 | 1.63 | 100.00 |

Yams: (*a*) Yam "tugue," *Dioscorea fasciculata*, showing method of planting. There are four roots planted around each bamboo pole.

(*b*) Illustration showing typical yam tubers of the better types, *D. alata*. Note the length in comparison with the 6-inch scale.

*Analyses of yams, Bureau of Science, Manila, P. I., 1915*—Continued.

| No. | Remarks. | Weight. | Moisture. | Ether extract. | Sucrose. | Reducing sugars. | Protein. | Ash. | Starch. | Crude fiber. | Undetermined. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Gms.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* |
| 25 | *D.* sp. | 340 | 70.30 | 0.23 | 0.40 | 0.40 | 1.08 | 0.73 | 19.47 | 0.68 | 6.71 | 100.00 |
| 26 | *D. alata* | 885 | 67.45 | .38 | .40 | .53 | 1.16 | 1.09 | 24.12 | .81 | 4.06 | 100.00 |
| 27 | *D.* sp. | 430 | 65.62 | .86 | .25 | .32 | 1.76 | 1.13 | 25.74 | 1.54 | 2.78 | 100.00 |
| 28 | do | 675 | 63.55 | .78 | .17 | .21 | 2.79 | 1.11 | 28.10 | 1.24 | 2.05 | 100.00 |
| 29 | do | 580 | 66.55 | .19 | .33 | .26 | 2.66 | 1.41 | 27.00 | 1.03 | .57 | 100.00 |
| 30 | do | 1,160 | 67.77 | .26 | .33 | .38 | 3.76 | 1.32 | 24.21 | .94 | 1.03 | 100.00 |
| 31 | *D.* sp. (poison) | 770 | 74.48 | .19 | .17 | .24 | 1.41 | 1.08 | 18.79 | .56 | 3.08 | 100.00 |
| 32 | *D.* sp. | 390 | 68.86 | .17 | .33 | .57 | 3.55 | .80 | 20.67 | .74 | 4.31 | 100.00 |
| 33 | do | 580 | 65.77 | .20 | .33 | .46 | 5.42 | .84 | 25.74 | .61 | .63 | 100.00 |
| 34 | do | 510 | 64.10 | .15 | .33 | .32 | 1.95 | 1.37 | 27.59 | 1.36 | 2.83 | 100.00 |
| 35 | *D.* sp. (poison) | 750 | 72.49 | .13 | .33 | .40 | 1.28 | .96 | 19.19 | .63 | 4.59 | 100.00 |
| 36 | *D.* sp. | 455 | 72.02 | .15 | .50 | .37 | 1.56 | .87 | 19.21 | .58 | 4.74 | 100.00 |
| 37 | do | 600 | 67.02 | .15 | .33 | .45 | 1.80 | .92 | 22.42 | .34 | 6.57 | 100.00 |
| 38 | *D.* sp. (poison) | 480 | 75.28 | .28 | .17 | .23 | 1.75 | .63 | 17.45 | .60 | 3.61 | 100.00 |
| 39 | *D. alata* | 680 | 65.92 | .19 | .33 | .40 | 1.36 | .71 | 24.26 | .46 | 6.37 | 100.00 |
| 40 | do | 1,900 | 67.02 | .08 | .26 | .24 | 2.11 | .90 | 22.28 | .20 | 6.91 | 100.00 |
| 41 | *D.* sp. | 1,700 | 69.20 | .06 | .17 | .38 | 1.16 | .21 | 20.30 | .38 | 8.14 | 100.00 |
| 42 | do | 860 | 72.73 | .10 | .33 | .63 | .82 | 1.06 | 19.19 | .10 | 5.04 | 100.00 |
| 43 | do | 880 | 70.64 | .01 | .41 | .31 | 2.31 | 1.49 | 19.49 | 1.30 | 5.04 | 100.00 |
| 44 | do | 420 | 68.64 | .008 | .33 | .56 | 1.65 | 1.86 | 22.60 | .46 | 3.89 | 100.00 |
| 45 | do | 530 | 74.63 | .13 | .50 | .74 | 2.77 | 1.64 | 18.64 | .95 | ------ | 100.00 |
| 46 | do | 270 | 57.31 | .27 | 3.75 | 2.77 | 2.23 | 1.17 | 24.12 | 1.29 | 7.09 | 100.00 |
| 47 | do | 370 | 73.25 | .10 | 2.60 | 1.31 | 1.59 | 1.02 | 15.48 | 1.00 | 3.65 | 100.00 |
| 48 | do | 205 | 57.41 | .13 | 1.30 | 1.27 | 2.41 | 1.58 | 27.27 | .65 | 7.98 | 100.00 |
| 49 | do | 275 | 56.32 | .13 | 3.99 | 1.54 | 3.11 | 1.42 | 25.79 | 1.96 | 5.74 | 100.00 |
| 50 | do | 165 | 55.29 | .56 | .65 | 1.20 | 2.94 | .91 | 29.70 | .52 | 8.23 | 100.00 |
| 51 | do | 275 | 57.60 | .07 | .65 | 2.56 | 1.53 | .50 | 24.53 | .84 | 11.72 | 100.00 |
| 52 | *D.* sp. [a] | 120 | | | | | | | | | | |
| 53 | *D.* sp. | 235 | 61.17 | .03 | 1.15 | 1.83 | 2.86 | .95 | 20.37 | .80 | 10.89 | 100.00 |
| 54 | do | 1,090 | 61.59 | .02 | ------ | .77 | 1.88 | 1.29 | 19.84 | .77 | 13.94 | 100.00 |
| 55 | do | 145 | 74.10 | .05 | .16 | .37 | 1.51 | 1.04 | 18.65 | .84 | 3.27 | 100.00 |
| 56 | do | 855 | 68.95 | .20 | .33 | .52 | .85 | 1.03 | 21.25 | .78 | 6.09 | 100.00 |
| 57 | do | 310 | 65.67 | .11 | .50 | .69 | .98 | 1.12 | 22.40 | .92 | 7.61 | 100.00 |
| 58 | do | 420 | 56.59 | .30 | 1.07 | 1.28 | 2.80 | 1.48 | 24.00 | 1.22 | 11.24 | 100.00 |
| 59 | do | 295 | 77.19 | .03 | .17 | .32 | .92 | .98 | 14.96 | .65 | 4.78 | 100.00 |
| 60 | do | 230 | 73.74 | .06 | .33 | .40 | 1.02 | 1.26 | 16.87 | .32 | 6.98 | 100.00 |
| 61 | *D.* sp, [a] | 170 | | | | | | | | | | |
| 62 | *D.* sp. | 285 | 69.87 | .02 | .50 | .61 | 1.32 | .94 | 18.97 | .71 | 7.06 | 100.00 |
| 63 | do | 250 | 72.91 | .06 | .26 | .45 | 2.34 | 1.02 | 18.44 | .47 | 4.05 | 100.00 |
| 64 | *D.* sp. [a] | 195 | | | | | | | | | | |
| 65 | *D.* sp. | 130 | 61.18 | .08 | .33 | .42 | .98 | 1.42 | 20.46 | 1.00 | 14.13 | 100.00 |
| 66 | do | 135 | 57.50 | .21 | .25 | 3.21 | 2.72 | 1.78 | 25.17 | 1.43 | 7.73 | 100.00 |
| 67 | *D. daemona* [a] | 245 | | | | | | | | | | |
| 68 | *D. daemona* | 235 | 61.25 | .02 | .98 | 1.17 | 2.33 | 1.23 | 22.07 | 1.20 | 9.85 | 100.00 |
| 69 | *D. daemona* [a] | 286 | | | | | | | | | | |
| 70 | *D. daemona* | 315 | 67.10 | .04 | .73 | .99 | 2.59 | 1.15 | 21.88 | .98 | 4.50 | 100.00 |
| 71 | *D. daemona* [a] | 270 | | | | | | | | | | |
| 72 | *D. daemona* | 365 | 65.52 | .62 | .90 | 1.48 | 1.83 | 1.00 | 25.08 | 1.12 | 2.45 | 100.00 |
| 73 | do | 335 | 58.16 | .13 | 1.20 | 1.37 | 1.43 | 1.44 | 26.24 | 1.67 | 8.36 | 100.00 |
| 74 | do | 195 | 60.84 | .02 | 1.07 | .96 | 2.14 | 1.33 | 23.75 | 1.06 | 8.83 | 100.00 |
| 75 | do | 310 | 52.12 | .15 | 2.48 | 3.49 | 3.02 | 2.41 | 28.04 | 1.76 | 6.53 | 100.00 |
| 76 | do | 205 | 65.20 | .25 | 1.54 | 2.03 | 2.50 | 1.33 | 24.54 | 1.33 | 1.22 | 100.00 |
| 77 | do | 180 | 58.55 | .18 | 2.03 | 1.92 | 3.18 | 1.47 | 25.92 | 1.59 | 5.16 | 100.00 |
| 78 | *D. daemona* [a] | 75 | | | | | | | | | | |
| 79 | *D. daemona* | 370 | 65.73 | .09 | 1.24 | 1.75 | 3.20 | 1.59 | 23.34 | .98 | 2.08 | 100.00 |
| 80 | do | 295 | 59.31 | .15 | 1.49 | 2.14 | .89 | 1.60 | 24.57 | 1.56 | 8.27 | 100.00 |
| 81 | do | 290 | 61.30 | .27 | 1.05 | 1.67 | 3.00 | 1.23 | 23.88 | 1.11 | 6.49 | 100.00 |
| 82 | *D. daemona* [a] | 170 | | | | | | | | | | |
| 83 | *D. daemona* | 365 | 58.25 | .30 | 1.78 | 2.14 | 3.61 | 2.11 | 26.28 | 1.42 | 4.11 | 100.00 |
| 84 | *D. daemona* [a] | 230 | | | | | | | | | | |
| 85 | *D. daemona* | 215 | 59.92 | .32 | 2.25 | 2.56 | 2.89 | 2.08 | 25.74 | 1.63 | 2.61 | 100.00 |
| 86 | do | 634 | 68.59 | .04 | 2.60 | .43 | 1.38 | .92 | 19.49 | 2.00 | 4.55 | 100.00 |
| 87 | do | 296 | 52.03 | .08 | 5.21 | .43 | 1.16 | .87 | 18.09 | .87 | 13.26 | 100.00 |
| 88 | do | 237 | 65.63 | .03 | 1.96 | .24 | 1.01 | .90 | 20.39 | .77 | 9.07 | 100.00 |
| 89 | *D. daemona* [a] | | | | | | | | | | | |
| 90 | *D. daemona* | 153 | 47.27 | .07 | 3.93 | .85 | 2.22 | 1.37 | 36.36 | .46 | 7.47 | 100.00 |
| 91 | do | 275 | 53.88 | .05 | 3.93 | .40 | 1.63 | 1.19 | 29.03 | .5 | 9.35 | 100.00 |
| 92 | do | 345 | 74.94 | .06 | 1.29 | .46 | 1.59 | .72 | 9.29 | .57 | 11.08 | 100.00 |
| 93 | do | 129 | 41.91 | .03 | 2.07 | .39 | 1.70 | 1.84 | 19.39 | 1.24 | 31.43 | 100.00 |
| 94 | do | 200 | 56.47 | .06 | 1.67 | .45 | 1.32 | 1.69 | 21.39 | .98 | 15.97 | 100.00 |
| 95 | do | 100 | 40.64 | .06 | 1.62 | .73 | 1.65 | 1.51 | 17.79 | 1.08 | 34.92 | 100.00 |
| 96 | do | 185 | 38.00 | .04 | 1.13 | .49 | 1.54 | 1.62 | 36.05 | 1.12 | 20.01 | 100.00 |

[a] Rotten.

# THE MANUFACTURE AND USE OF LIME FOR CANE LANDS AND SUGAR MANUFACTURE.

By CLEVE W. HINES, M. S., *Sugar Technologist.*

Lime has been manufactured on a rather small scale in the Philippine Islands since time immemorial. This product, nevertheless, has invariably been of a low grade due largely to the lack of attention in selecting suitable carbonate rocks as well as the very crude systems employed in burning the lime.

For the most part no kilns were used at all in this work until recently or if a sort of kiln was employed, it consisted only of a small vertical shaft near the side of a hill and quite often this was not even lined with heat-resisting material. The usual system of burning the lime consisted of piling up a small amount of wood in a shallow excavation which was later covered with the shells or other forms of lime rock and the whole carefully covered with earth. In order to have a free circulation of air for the combustion of the fuel, hollow bamboo tubes were inserted in a vertical position at the top as well as others in a horizontal position near the base of the cone-shaped heap.

The lime manufactured by these crude methods answered very well for the making of mortars for ordinary building purposes, and the sugar planters were even content to use this low-grade material in clarifying their cane juices, but with the advent of modern methods in sugar manufacture the poor grades of lime were no longer acceptable in this work. It was therefore necessary for these factories to secure their lime from abroad. Accordingly many tons of high-grade lime were imported into the Islands each year for use in the factories. It is interesting to note that after seeing the results of the use of a good grade of lime in the modern factories even the muscovado factories have found it more desirable to use the high-grade material in the clarification of their juices although it costs more than the low-grade product, since a better sugar is obtained.

The price of imported lime as well as the freight thereon has gradually advanced during the past several years until this

material is now an item of importance to the sugar producer. With a view to reducing this unnecessary expense many planters in the sugar-producing provinces are looking forward to the production of high-grade lime locally.

There is no good reason why any lime should be imported into the Islands since the extensive deposits of calcium carbonate here are ample to supply all the requirements of the Islands for a long time to come as well as to provide material for export.

The use of lime on cane-sugar plantations could ill be dispensed with since it fills a very important place in both the field and factory. Its effect on growing cane is observed from the time the young cane is starting until the crop is harvested. In this connection, it forms a necessary plant-food material, sweetens the soil, improves its condition for the development of soil bacteria and improves its mechanical condition, as well as various other functions which will be discussed later.

The principal use to which lime is put in the sugar factory is in the precipitation of impurities contained in the juice subsequent to its concentration. There are few systems of clarifying juices which do not employ this reagent. One of the latest systems devised for clarifying juices removes practically all of the sugar even from the molasses with no other reagent than the constituents of lime rock, namely calcium oxide and carbon dioxide. In addition to its important use as clarifying reagent this material serves as an excellent germicide in keeping down bacterial infection throughout the factory.

## OCCURRENCE.

The element calcium is a mineral which is very active in its pure state and therefore it never occurs in nature in this condition. It readily combines with oxygen and other elements forming the various compounds many of which are extremely stable. When the oxide combines with carbon dioxide, lime rock is found. This occurs in various stages of purity depending largely upon its derivation. The extremely pure crystalline form known as calcite or Iceland spar is a special primistic crystal extensively used in making Nicol prisms for polariscopes.

The ordinary grade of calcium carbonate is one of the most common as well as one of the most widely distributed minerals found on the earth's surface. It occurs in large masses in the form of marble, limestone, and chalk and often in large deposits where great islands are built up from these deposits of the calcareous bodies of countless coral insects. In fact the numerous deposits found in the interior of continents are often

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of organic origin. These vast deposits are the mineral remains of animal life, such as crinoids, corals, and molusks during bygone ages when the land was submerged.

In addition to the above deposits limestone of sedimentary origin often occurs. The limestone found in these deposits often appears as stalagmites, stalactites, pillars, and in various other forms. These are from waters bearing lime in the hydroxide or other forms which come in contact with waters laden with carbon dioxide, the carbonate form or limestone resulting, and since this is practically insoluble in water it is deposited as mentioned above. The following equation shows how limestone is formed in such cases:

> **Calcium hydroxide Ca $(OH)_2$ plus carbon dioxide $CO_2 \rightarrow$
> Calcium carbonate or limestone $CaCO_3$ plus water $H_2O$.**

Since calcium does not occur in the pure state, it is obvious that limestone is not formed in nature directly from the elements themselves. Instead, combinations of these elements unite, forming calcium carbonate according to the above equation. In fact, this union is taking place constantly in various parts of the earth's surface and in many instances it gives rise to the deposits where the rocks are widely quarried for economic purposes. This same change is constantly taking place where the lime in the oxide and hydroxide form used on the field and in the factory is left to stand in the open air or in contact with water laden with carbon dioxide. Likewise, a similar chemical change is constantly taking place only to a more limited extent when the lime (calcium oxide and calcium hydroxide) is applied to cane juices heavily laden with impurities. When lime is applied in the clarification of juices it first combines with the acids which are neutralized. A portion then unites with various impurities and changes them from light flocculent substances to a heavier form. This gives rise to the heavy precipitate found in the lower portion of the settling tanks and defecators.

## MANUFACTURE OF LIME.

In the manufacture of lime from calcium carbonate the reverse process takes place to that of forming the rock. Just as heat is evolved during the union of certain chemical compounds heat is also required in breaking up the compounds. In the case of the reducing of calcium carbonate to the oxide form intense heat is required to bring about the change. The following formula indicates the change which takes place:

> Calcium carbonate $CaCO_3$ in the presence of a high temperature$\rightarrow$
> Calcium oxide or quicklime $(CaO)$ plus carbon dioxide $CO_2$.

Small lime kiln at the Mindoro Sugar Factory, San Jose, Mindoro, P. I.

Where it is desired to employ carbon-dioxide gas in the clarification of juices the lime is always burned at the factory. This system is universally employed at the beet-sugar factories and it is used to some extent nowadays in connection with cane-sugar manufacture where improved systems of clarification with carbon-dioxide gas are employed in the manufacture of high-grade plantation sugar.

## LIMEKILN.

The kiln or furnace in which lime is burned consists essentially of a suitable structure where alternate layers of the lime rock and combustible material are deposited and where suitable conditions obtain for burning the lime. The modern types of kilns used in preparing lime for sugar factories usually consist of cylindrical structures of masonry work or iron which are lined with fire-resisting brick. Figure 1 is a common type of kiln found in American factories. The so-called continuous kilns are the most satisfactory. These are so arranged that they may be filled with new rock and combustible material and the finished lime removed at the same time. This permits the continuous production of carbon dioxide as well as lime and produces a high-grade finished product when properly operated. Plate X shows a view of a small kiln of this type. Where such an expenditure is not feasible or where lime only is desired and no attention is paid to the carbon-dioxide gas one of the more simple kilns will answer as well.

In choosing a fuel for the burning of lime it is desirable to select one giving a minimum of ash and tarry matter. For this reason coke and gas are considered the very best. Second to these comes a good grade of coal but it is usually desirable to mix the coke and coal, where the latter is employed to facilitate the burning. In the simpler forms of kilns, wood is used as fuel.

When lime is manufactured for use in the clarification of sugar-house products it is desirable that a pure article be employed. The crude material from which this is derived is found in great abundance in the various parts of the Philippine Islands. The usual form of this material used in the native factories consists of sea shells and coral rock. Where this material is properly selected and weathered for some time until the salt is washed away it will answer very satisfactorily.

The second form consists of sedimentary deposits such as those found in several parts of the Archipelago, which are in the main quite pure. There are usually found in all quarries strata of material which are not of the purest type but these

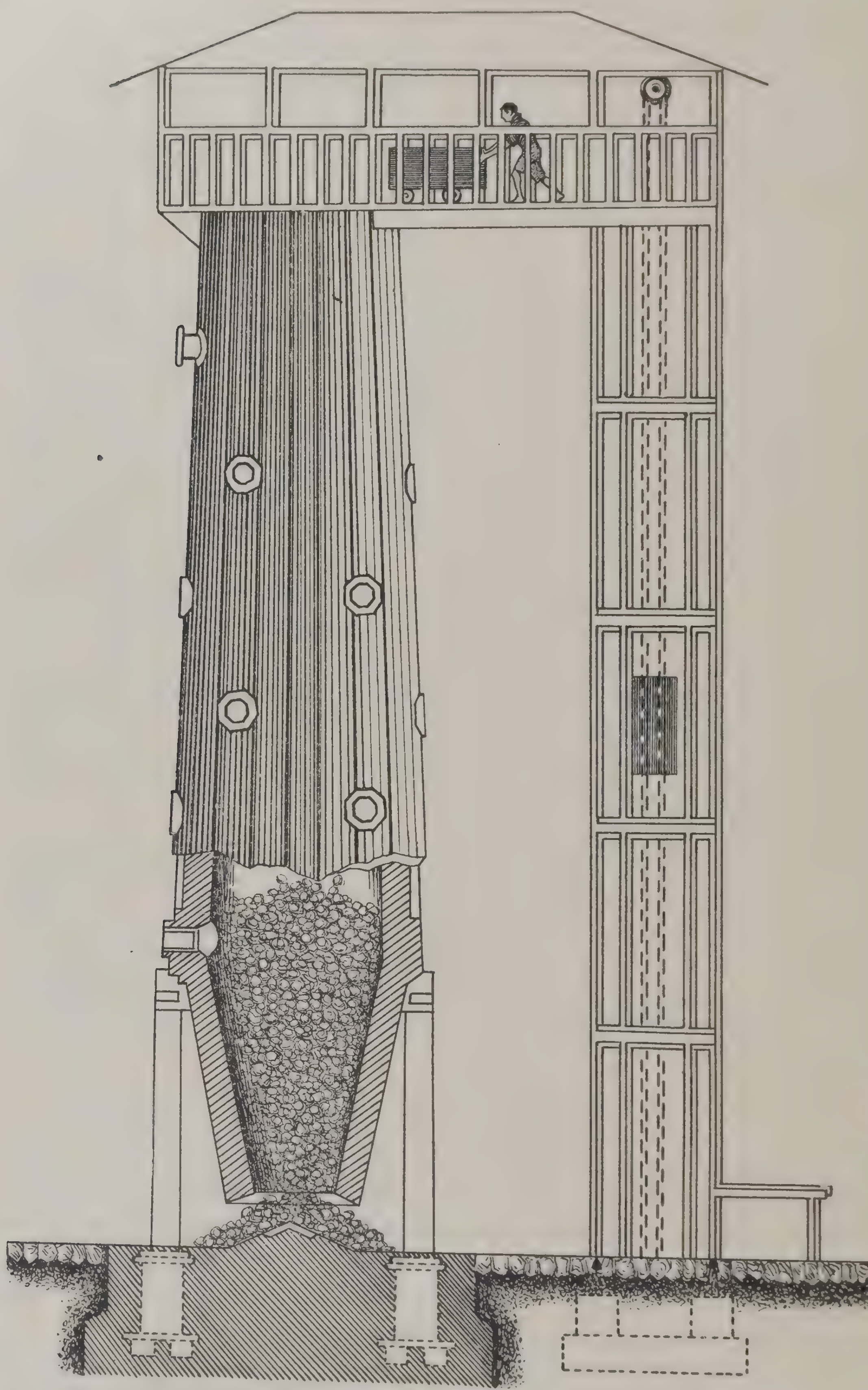

FIG. 1. Type of lime kiln often used in producing lime and carbon dioxide for sugar factories.

may be carefully separated when the rock has been broken up and transferred to the kiln.

The third class of rock is of fossiliferous origin and this likewise must be sorted before it is prepared for the kiln.

One of the most troublesome impurities found in lime when used in the clarification of cane juices is magnesium due to the fact that this substance collects as a heavy coat on the evaporator tubes and impairs the transmission of heat to the boiling juices. Dr. Geerligs gives the maximum content of this material in lime when used in clarifying juices as 2 per cent. Another troublesome impurity is iron. This, however, does not usually occur in large quantities and the presence of even a small amount may easily be detected by the brown color which it imparts to the rock.

The method followed in burning the lime rock determines to a great extent the grade of the finished product. If the heat is not applied evenly throughout the kiln there will be portions of the rock left unburned while other portions are overburned. This results in a very unsatisfactory product as well as an extra burden of expense due to the loss of heat units. It is important, therefore, that as low a temperature as possible be employed to decompose the lime and convert it into the oxide form, and this must be properly distributed throughout the rock. The temperature may be as low as 700° C. where the gas is immediately removed but where a pressure of the gas is maintained above the burning lime as in the case where the gas is used in the sugar factory, the carbon dioxide and quicklime recombine forming calcium carbonate. For this reason a higher temperature is required in such cases.

After the class of fuel to be used in burning the lime has been selected, it is necessary to conduct some experiments with this material and with the particular lime rock employed in order to determine the right proportions of fuel and lime to be used in filling the kiln. Whether weighing or measuring methods are employed the charges of lime and fuel should be admitted alternately in order to have them properly mixed.

It is necessary to start the burning some days before the factory is to begin grinding in order to insure a supply of both lime and carbon dioxide. After the burning has progressed for sometime samples of the burnt rock are withdrawn and tested by placing them in a beaker with a small quantity of water. If the lime has been properly burned, it will be completely dissolved during this test and leave no sediment. That portion of the lime which has been well burned should then be

removed and a similar amount of material introduced at the top. After the work is well under control the filling and removing may go on continually.

### LIME IN CANE-JUICE CLARIFICATION.

High-grade lime finds its most extensive use in the clarification of sugar-house products subsequent to the crystallization of sugar. Since the object in view in the application of this material to cane juices is to effect the precipitation of the impurities therein contained in order that a pure juice may be had for concentration, it is obvious that the lime should not contain many impurities. Another reason why a high-grade lime should be employed is that magnesium forms an impurity of ordinary lime and when cane juice containing this material is boiled, compounds of the magnesium are deposited on the evaporator tubes forming hard scales which are very difficult to remove. These incrustations have the effect of lowering the coefficient of heat transmitted from the steam to the boiling juice, thus retarding the work of concentration as well as causing an extra outlay of labor.

Another objection to the use of impure lime is that iron is often contained therein and this combines with various impurities in the cane juice forming dark-colored products which are almost impossible to remove with the ordinary methods of clarification. This impurity is receiving greater attention every day due to the adoption of methods for the manufacture of white sugar directly in one continuous process at the plantation factory. The majority of the impurities in the lime are more or less soluble in cane juice and while they may be present in such small amounts as not to perceptibly lower the coefficient of purity of the juice yet the ill effects experienced in impairing the color of the clarified juice are of far more importance than the purity coefficient alone, especially when plantation white sugar is manufactured. For the above reason it is important to select a high-grade lime for the purpose.

The quality of the lime used for cane-juice clarification depends to a large extent upon three factors, namely, the quality of the original lime rock from which the lime was derived, the proper burning of the rock to convert it into the oxide form, and the treatment given the finished product from the time it was burned until prepared for the factory.

While it is practically impossible to find deposits of any magnitude containing only high-grade material yet it is a comparatively simple matter to separate the inferior material from that

used for the manufacture of lime. The rock must first be broken into pieces before it may be conveyed to the kiln and during this work the sorting should be done. The impure rock may usually be detected by the difference in the color as well as in the formation. The presence of iron is invariably detected by a red or brown color. Where the kiln is located some distance from the sugar factory, immediately after the lime has been burned it should be placed in air-tight containers to preserve it in the oxide form until ready for use. Used kerosene cans and metallic drums answer very satisfactorily for this purpose and where these receive the proper care they may be used a number of times. If the lime is not properly protected it first absorbs moisture and later combines with the carbon dioxide from the air forming the original class of material, limestone. This impairs the efficiency of the lime and requires that more material be employed to neutralize the acidity and precipitate the impurities in the juice. It assists to some extent, however, in mechanically removing the various suspended impurities.

In preparing the lime for the clarification of cane juices a weighed portion is put into a measured quantity of water and thoroughly mixed. During this time a great deal of heat is evolved. The resultant mass is known as milk of lime and various amounts of this material are added to the cane juices depending upon the acidity as well as the amount of impurities present. In some systems the lime is applied as the oxide in a finely pulverized form. This system must be handled with care, however, in order to prevent dark-colored glucose combinations from forming, which would impair the color of the finished sugar unless the molasses film is completely washed away from the crystals.

## APPLICATION OF LIME TO SOILS.

Lime furnishes a necessary constituent in building up the cellular tissues of practically all plants, although some crops use a larger amount of this material than others. It has been found that the ash of mature sugar cane contains approximately 3.5 per cent of lime. The ash content of such cane averages approximately 0.5 per cent which would mean that each ton of cane removes from the soil approximately 1.75 kilos of lime.

Although the results of the extensive research work on the building up of plant tissues would indicate that lime may be replaced by other elements to a limited extent, yet this can only take place to the detriment of the crop. In view of the cheapness of this material it is not wise to permit a deficiency to

exist especially since any excess of lime over the actual requirements of the plant acts in a beneficial manner in improving the mechanical condition of soil. Lime has been used to some extent on sugar plantations for many years. It was at first considered as a fertilizer by many planters because of the increased yields which resulted when this material was used in sufficient quantity. While it is possible that in some cases a portion of the lime applied to cane lands is used in building up the plant tissues, yet the most extensive use for this material is in neutralizing the acid condition of the soil. The majority of the soils on sugar plantations here in the Philippine Islands are more or less acid. This is universally true of the low, wet lands and also the majority of lands which have borne a number of ratoon crops without occasional applications of lime or on which the cane trash has not been burned. The stumps of the previous plants as well as defective stalks, cane tops and leaves give off much acid during their decomposition. Where this material is burned on the field, only the ash remains, which reduces to some extent the acidity of the soil, but this is done at the expense of the much-needed humus-forming organic matter.

The ordinary grade of lime answers equally as well for application to soils as the higher grades. It is not even necessary to have the calcium in the oxide and hydroxide form though these give quicker results and are therefore preferable in correcting certain conditions of the soil. The relative value of the oxide, hydroxide, and carbonate forms are as follows: Fifty-six kilos of the oxide equal approximately 74 kilos of the hydroxide or 100 kilos of the carbonate.

While lime is employed in rare cases to supply the deficiency of calcium in the soil, its more important use is in neutralizing the acid condition of low, wet soils and those soils which contain a great deal of acid from the decay of organic matter and the decomposition of various chemical compounds. There are few plants which will thrive well in such soils and sugar cane in particular readily shows the ill effect of acidic conditions. Where rotation of crops is practiced on the plantation, legumes are extensively employed in order to supply nitrogen to the soil. The success of growing legumes is often determined by the condition of the soil with reference to its acidity. Few, if any, of the legumes used on sugar plantations will thrive well on acid soils. This class of soil is likewise unsuitable for the growth of the bacteria found in the nodules of the rootlets. Since the nitrogen-gathering qualities of legumes are determined by the

presence of bacteria in the nodules, it is extremely essential to maintain in the soil suitable conditions for the development of these bacteria.

A fairly good yet not infallible method of determining whether a soil is acid is to test it with strips of blue litmus paper which has been kept in containers away from the air. A small sample of soil is prepared from the samples collected in four or five locations in the plot to be tested. The samples are carefully mixed and about a handful is separated and mixed to the consistency of heavy dough, using clean water, preferably distilled water. A strip of litmus paper is inserted in the center of a ball of the mud and left for fifteen minutes or one-half hour. If the color of the paper has changed to red it is a fair indication that the soil is acid and requires lime for sweetening apart from that which might be required for other purposes.

Another important use to which lime may be put is in the improvement of the mechanical condition of soils. There are two classes of soils which may be benefited by its use. When it is applied to certain heavy clay soils the particles of clay become flocculated or granulated, making the soil more porous. This improves drainage, aeration, and the movement of soil water by capillarity as well as causing the soil to respond better to cultural operations.

The writer recently investigated clay soils on the Iwahig Penal Colony Farm, Island of Palawan, P. I., with a view to employing them in the production of sugar. These lands have been planted to rice for several years but it was found utterly impossible to retain a supply of water over the rice within the bounds of the earthen dykes, notwithstanding the fact that this class of soil in which yellow clay predominates is usually very retentive. A chemical analysis showed the soil to contain over 5 per cent calcium which had caused a flocculation of the clay particles and thus made the soil so porous that the water filtered through.

Where the soils are too light, applications of lime often have the effect of cementing the particles together and making them more retentive. This treatment is especially important with such lands when subjected to an extensive dry season.

The form in which the calcium should appear, the amount of lime to apply, and the time to apply the lime are important questions to sugar planters.

It has been explained that the calcium may be applied to cane lands in any one of three forms, namely, the oxide, hydroxide, or the carbonate with equally as satisfactory results provided

that not too much of the two first-named forms is applied at a time and that sufficient time is given the last form to act. The oxide and hydroxide forms give the quickest results and at least a limited amount of one of these should therefore be employed on extremely acid soils if prompt results are desired. These, or at least the oxide, present the disadvantage of destroying the organic matter and causing a loss of plant-food material when used in too large quantities. On account of the trouble encountered in handling lime in the oxide form, the hydroxide or slaked form is usually preferred. This is prepared by pouring water over the newly burned lime which causes it to swell up and crumble into a fine powder. The carbonate is, however, the safest form to apply, but again it presents the disadvantage of being slow in its action. The writer has obtained the best results on cane lands here in the Philippines by making light applications of the oxide or hydroxide form, which is thoroughly incorporated in the soil, and following this by a second and heavier application, using the carbonate form. A sufficient amount of oxide should be added to neutralize the excess of acid and this usually consists of at least 200 or 300 kilos per hectare, depending upon the amount of acid in the soil. The carbonate should consist of 2 tons or more per hectare if it is desired to improve the mechanical condition of the soil as well. It is more profitable to make heavy applications and not to apply the lime so often rather than to make numerous light applications.

The best time to apply the lime is after the land has been plowed and before it is harrowed. Where disks are used in preparing the soil there is a very good opportunity of mixing the lime with the soil.

## WASTE PRODUCTS AS FERTILIZERS.

The waste products from the limekiln, if properly prepared, make suitable material for sweetening and otherwise improving the condition of soils. When the rock in the original or carbonate form is employed it should be crushed into fine particles and spread evenly over the fields. The same treatment should be given any discarded burnt lime from sweepings except that it is unnecessary to subject this to the crushing process.

Where the carbonation process is used in the clarification of juices the settlings from the subsiders and filterpress cakes contain a great deal of the exhausted lime. This material makes an excellent fertilizer while at the same time it usually exerts sweetening power in the soil due to lime which is present in the carbonate form.

# RESUMÉ OF THE WORK OF THE PLANT INDUSTRY DIVISION DURING THE FISCAL YEAR 1916.

By A. M. BURTON, *Chief, Plant Industry Division.*

## RICE WORK.

The principal work done during the forepart of the year was completing the threshing and cleaning of the rice harvested from the seed propagation and the various experimental plots at Alabang, Rizal. All the laboratory work on the experiments was also done during this period, including the testing for germination in 75-liter lots, of all the seed produced. There were 19,221 liters of pedigreed seed, composed of six varieties as follows:

| | Liters. |
|---|---|
| Roxas | 6,172 |
| Cruz | 5,145 |
| Apostol | 4,192 |
| Conner | 2,332 |
| Macan | 690 |
| Inasimang | 690 |
| Total | 19,221 |

Considerable time was also devoted to computing, recording and transcribing data obtained from the experiments and other rice work to the cards and permanent books, as well as in purchasing and testing commercial seed rice for future distribution.

The computing, recording, etc., of data obtained from last season's planting and the testing of the stock seeds for distribution was continued and completed during the first half of the year, excepting those pertaining to the head-to-the-row test which required a great deal of adding and averaging.

Preparation for the 1917 season's planting was commenced during the forepart of the second quarter of the year. It was planned to have all the upland work done at La Carlota Experiment Station, Occidental Negros, and the lowland work at Alabang Stock Farm, Rizal. Following is a brief outline of the various activities carried on under this project during the year.

*Experiment No. 1. General variety test.*—Testing in a comparative way different varieties, both of upland and of lowland rices, for the purpose of determining and selecting the best and most promising ones for improvement and propagation.

The lowland test includes 147 varieties, consisting of 71 retained from last season's test and 76 new ones, mostly bearded, recently collected by Mr. S. Apostol, mainly from the Provinces of Pangasinan and Nueva Ecija. There are 82 nonbearded and 65 bearded varieties in the test, of which 7 are glutinous. It was decided to test and improve more of the bearded varieties than has been done heretofore, because the Ilocano and the Pangasinan farmers insist on having this kind of rice and will not plant the beardless rice. Following are the main results in brief:

Varieties under different names but found to be duplicate:

| Permanent No. | Variety names. | Origin of seed. |
|---|---|---|
| 36 | Baliw | |
| 74 | Binacroy I | S. I. Potot, Pangasinan. |
| 47 | Barangcal | Dao, Antique. |
| 262 | Capotol | Bohol. |
| 396 | Grana II | Alaminos, Pangasinan. |
| 463 | Iray | Sual, Pangasinan. |
| 635 | Mulan-ay | |
| 1143 | XE | Rizal. |
| 981 | Sinan-Fabian I | Guimba, Nueva Ecija. |
| 998 | Macarañag II | Dagupan, Pangasinan. |
| 1053 | Almisqui | Tayug, Pangasinan. |
| 1064 | Binalayang | Do. |
| 1134 | Sampurado | Do. |
| 1057 | Balolaqui | Do. |
| 1087 | Dalusòn a Biit | Rosales, Pangasinan. |
| 1063 | Binacroy II | Tayug, Pangasinan. |
| 1088 | Dinaluson | Rosales, Pangasinan. |
| 1139 | Sinan-Fabian III | Do. |
| 1066 | Binato II | Concepcion, Tarlac. |
| 1069 | Bulastog or Ortoc | Rosales, Pangasinan. |
| 1116 | Mimis a Purao | Tayug, Pangasinan. |
| 1131 | Quinalibo II | Concepcion, Tarlac. |
| 983 | Buluhan | Calatagan. Batangas. |
| 988 | Quinabebe II | Tarlac, Tarlac. |

A small number of varieties have shown more or less strong characteristics of upland rice, and these have been specially noted and will be included in the upland variety test the coming season. The following table shows the range of yield and that of time of maturity of the different varieties in the test.

| Maturity. | | Yield. | |
|---|---|---|---|
| Range in days. | Number of varieties. | Range in liters per hectare. | Number of varieties. |
| 111-120 | 2 | 1,500-3,000 | 6 |
| 121-130 | 12 | 3,000-3,750 | 3 |
| 131-140 | 14 | 3,750-4,500 | 10 |
| 141-150 | 15 | 4,500-5,250 | 18 |
| 151-160 | 14 | 5,250-6,000 | 19 |
| 161-170 | 19 | 6,000-6,750 | 31 |
| 171-180 | 33 | 6,750-7,500 | 21 |
| 181-190 | 15 | Above 7,500 | 23 |
| 191-200 | 9 | Without data | 6 |
| Above 200 | 10 | Total | 147 |
| Without data | 4 | | |
| Total | 147 | | |

The upland test was planted toward the end of the second quarter, and included 58 varieties consisting of 20 samples from seeds furnished the College of Agriculture by this office for planting the previous year, 10 transferred from the lowland test and 28 new varieties. Only eight were bearded varieties.

Of the total number, four varieties failed to germinate and two, the Eput-Ebun (Per. No. 379) and the Bulastog (or Ortoc, Per No. 1069), were abandoned for being too late, the former having headed out at the age of 143 days, and the latter at 146 days. Three varieties ripened in less than 120 days from the time of seeding, while three other varieties yielded more than 5,250 liters per hectare. Below is a table showing the maturity and yield ranges of the different varieties in the test:

| Maturity. | | Yield. | |
|---|---|---|---|
| Range in days. | Number of varieties. | Range in liters per hectare. | Number of varieties. |
| 110-120 | 3 | 750-1,500 | 1 |
| 120-130 | 8 | 1,500-2,250 | 3 |
| 130-140 | 7 | 2,250-3,000 | 10 |
| 140-150 | 17 | 3,000-3,750 | 11 |
| 150-160 | 17 | 3,750-4,500 | 13 |
| Failure | 6 | 4,500-5,250 | 11 |
| | | Above 5,250 | 3 |
| Total | 58 | Failure | 6 |
| | | Total | 58 |

*Experiment No. 2. Age-of-seedlings test.*—To determine the proper age at which seedlings of *early*, *medium* and *late* maturing varieties should be transplanted.

This experiment was a success. While the relative yields of the various plats can not as yet be given here, as several plats of the late varieties are still to be harvested, the results obtained so far demonstrate clearly that there is an optimum age at which seedlings of a given class of rice should be transplanted.

*Experiment No. 3. Root-system study.*—In transplanting rice, the root system of the seedlings is more or less damaged, not only when the young plants are removed from the seed bed, but the transplanters purposely tear off with their hands a considerable portion of the roots, often leaving the roots only about 6 centimeters long, so as to facilitate transplanting. This experiment was designed to determine definitely the influence of such practice and to what extent it can be done without any ill effect on the development and yield of the rice crop.

The larger portion of the crop from this experiment is still to be threshed and the yield determined. The data on hand, however, are sufficient to indicate that the excessive removal of the seedlings' roots at transplanting, as practised by many, is detrimental, although not necessarily fatal, to the rice crop and is often the cause of low yields. Care should be taken to have the entire root system buried in the mud in transplanting.

*Experiment No. 4. Pedigree work.*—To improve a limited number of the most promising varieties by means of plant selection through the "head-to-the-row" culture. This work includes representative varieties of the *early*, *medium*, and *late* maturing groups so as to meet various local requirements. This experiment included 17 new varieties.

Most of the varieties have given excellent results, but a few of them will have to be discarded from the coming season test. The final selection, however, can not be made until the laboratory part of the work, which is now still in progress and forms probably 35 per cent of the experiment, shall have been completed.

*Experiment No. 5. Liming of replanted seed bed.*—It is a common experience that land previously used as a seed bed does not produce a good crop when replanted, even with the same seedlings that have been grown on it. There are many possible explanations of this phenomenon, and the experiment is designed to determine and correct in a practical way the defects that may be due to soil acidity by the use of lime in its various forms. Following are he main results in brief:

| Plat No. | Lime used. | Rate of application per hectare. | Days to mature. | Height of plants. | Number of heads per hill. | Calculated yield per hectare. |
|---|---|---|---|---|---|---|
| | | *Kilos.* | | *Cm.* | | *Kilos.* |
| IA | $CaCO_3$ | 3,600 | 141 | 117 | 3.81 | 1,932.9 |
| IB | None | | 142 | 115 | 4.76 | 1,536.1 |
| IIA | CaO | 2,000 | 137 | 131 | 5.52 | 2,130.1 |
| IIB | None | | 143 | 118 | 4.82 | 1,310.8 |
| IIIA | $CaCO_3$+CaO | 2,800 | 139 | 121 | 4.90 | 2,160.3 |
| IIIB | None | | 143 | 115 | 4.88 | 1,464.4 |

The average yield of the three check plats is 2,471 liters. It will be observed that in every case the limed plat gave a larger yield than the check or nonlimed plat, the highest yield having been obtained from No. IIIA plat, representing a gain of more than 50 per cent over the average of the check plats.

Plat IIA gained 48 per cent, while plat IA gained only 34 per cent over the check plat. With respect to the height of the plants in the various plats, IIIA was only second to IIA, and this relation is also true with regard to earliness, the check plats being practically uniform in each case.

While it is obvious from the above results that the addition of lime decidedly improved the productive capacity of land previously used as a seed bed, it may be said only as a general remark at this time that the practicability of this process will be determined principally by the cost and amount of lime available in a given locality.

*Experiment No. 6. Fertilizing of seed beds.*—This is to determine the effect of various quick-acting nitrogenous fertilizers on the production of seedlings and the benefits to be derived therefrom, with a view to the production of a good, heavy crop of grain. The fertilizers used were dried blood, leachings from mixed manure, sulphate of ammonia, and nitrate of soda.

The Apostol, one of the improved, medium-early varieties, maturing in about 140 days, was used in this experiment. The final results are briefly shown in the following table:

| Lot No. | Fertilizer used in the seed bed. | Average height of seedlings— At fifteen days. | Average height of seedlings— At transplanting. | Calculated yield per hectare. |
|---|---|---|---|---|
| | | *Cms.* | *Cms.* | *Kilos.* |
| A | None | 29.3 | 45.1 | 3,045.0 |
| B | Dried blood | 30.2 | 49.0 | 2,754.6 |
| C | Leaching, barnyard manure | 29.4 | 47.6 | 3,070.7 |
| D | None | 27.8 | 46.7 | 3,133.7 |
| E | Ammonium sulphate | 39.1 | 65.6 | 2,770.3 |
| F | Sodium nitrate | 29.4 | 52.3 | 2,833.8 |
| G | None | 38.0 | 41.6 | 3,342.7 |
| Average of A, D and C | None | 28.4 | 44.5 | 3,173.8 |

As the last column shows, the results did not bear out the assumption. This was due to the fact that all the beds had been seeded at the same rate (43 kilos per 400 square meters), and the seedlings of the fertilized beds had lodged more or less early, before they were old enough for transplanting, due to excessive growth of leaf blades with relatively weak trunks, characteristic of too thick seeding. Lodging injures the seedlings in that it induces node formation. This experiment will be repeated the coming season, but under a better plan as suggested by the present results.

*Experiment No. 7. Seed propagation.*—This is the planting on a large scale of the improved seeds produced as per Experiment No. 4, for the purpose of producing sufficient good seeds for coöperative demonstration purposes, for sale or free distribution, and all the land assigned to rice work at Alabang Stock Farm, Rizal, not occupied with special experiments was planted for seed production.

With the upland rice at La Carlota Experiment Station, Occidental Negros, this work was conducted on a still larger scale. Several hectares of the station's land were cultivated by tenants on the "share" basis, the Bureau furnishing the necessary seed. Only one variety, the Inantipolo II, was planted this year because this was the seed that gave the best results in every place that it was planted the previous season.

The amounts of seed produced both at the Alabang and La Carlota stations are given below:

| Station. | Variety name. | Permanent No. | Days to mature. | Amount. |
|---|---|---|---|---|
| | | | | *Kilos.* |
| Alabang | Lowland: | | | |
| | Apostol | 1001 | 144 | 2,982.9 |
| | Conner | 1002 | 142 | 509.0 |
| | Cruz | 1003 | 143 | 4,087.2 |
| | Roxas | 1004 | 146 | 1,538.8 |
| | Inasimang | 447 | 170 | 76.4 |
| | Macan I | 527 | 179 | 90.1 |
| | Piniling Daniel | 692 | 176 | 116.3 |
| | Total | | | 9,400.7 |
| La Carlota | Upland: Inantipolo II | 956 | 143 | 15,824.0 |
| | Grand total | | | 25,224.7 |

MISCELLANEOUS OBSERVATIONS.

*Plowing.*—It was found that five men with native plows and carabaos, working 8 hours a day, plowed an aggregate area of 6,573 square meters of lowland rice field. At this rate it would take 7.6 men to plow 1 hectare, or one man would plow the same area (1 hectare) in 7.6 days.

*Pests and diseases.*—The only disease of importance observed at Alabang was a kind of rice smut which affected individual grains at the dough stage, causing them to swell and decay, but even this appeared only in very negligible proportions.

*Harvesting with "Lincao."*—Two men, Doroteo del Monte (twice) and Juan Espeleta (once), were employed in this work, and the cutting was conducted on the "Cruz" crop when this was just ripe. The results are given in the table below:

| Harvester and working period. | Sheaves cut. | Grain harvested. | Area cut. |
|---|---|---|---|
| | | *Kilos.* | *Sq. meters.* |
| Doroteo del Monte working— | | | |
| 6¾ hours [a] | 208 | 159.12 | 621.33 |
| 1 day of 8 hours [a] | 266 | 203.67 | 795.30 |
| 6½ hours [b] | 222 | 163.17 | 650.20 |
| 1 day of 8 hours [b] | 273 | 200.82 | 800.25 |
| Juan Espeleta working— | | | |
| 7⅓ hours [c] | 265 | 217.30 | 969.43 |
| 1 day of 8 hours [c] | 289 | 237.05 | 1,057.56 |
| CALCULATED ON 1-HECTARE BASIS. | | | |
| Doroteo del Monte working— | | | |
| 12.6 days of 8 hours [a] | 3,348 | 2,561 | 1.00 |
| 12.5 days of 8 hours [b] | 3,414 | 2,510 | 1.00 |
| Juan Espeleta working 9.5 days of 8 hours [c] | 2,734 | 2,242 | 1.00 |

[a] Cutting at ordinary rate; crop about average; down; medium straw; fair to handle; average sheaf content, 0.765 kilogram.

[b] Cutting at ordinary rate; crop about average; erect, reclining; easy to cut when fixed down; average sheaf content, 0.735 kilogram.

[c] Cutting at fast rate; crop below average; thinner stand; short; smooth; easy cutting, average sheaf content, 0.82 kilogram.

Encouraged by the results from a small trial conducted last year, in which the seed was planted without previously plowing the ground, a little over 4 hectares—i. e., fully two-thirds of the entire field devoted to rice at Alabang—were planted with mungo (*Phaseolus radiatus*) as soon as the rice crop was removed during November and the forepart of December, while the soil was still moist. After the mungo seed was sown, a brush drag was run over the field so as to have all the beans come in contact with the soil. The seed was sown at the rate of 50 liters to the hectare.

The lots planted on November 10 began bearing pods about the end of December, and from all appearances the entire crop will yield sufficient beans to pay at least for the seed used and the work of sowing and dragging even if the crop is to be harvested on 50 per cent share basis. The main benefit to be derived from this work will, of course, be the improvement, both physically and chemically, brought about in the soil through the growth of the leguminous crop.

## GENERAL REMARKS.

During July and August transplanting was the principal field work at Alabang, while at La Carlota, where planting was done earlier, the crop was weeded twice. The making of field observations and taking data on all the experiments occupied the principal attention of the technical force connected with this project both at Alabang and at La Carlota from the very beginning.

During the latter part of the year harvesting was the main work both at Alabang and at La Carlota besides computing and compiling of data obtained. The harvest from the experimental plots was threshed and cleaned as soon as practicable after it was cut. Threshing was also commenced with the seed propagation crops. This season's crop was excellent as a whole in both places, and the experiments at Alabang were especially successful. The laboratory part of the pedigree work at Alabang was started about the middle of the last quarter.

Two thousand seven hundred and sixty liters of upland seed palay were harvested at La Carlota Experiment Station, and more than 15,000 liters pedigreed lowland seed were obtained from the seed propagation work at Alabang. In addition to these seeds, arrangements were made to buy a certain quantity of the rice raised by Bureau coöperators from the seed furnished them by the Bureau, so as to have about 37,500 liters of upland and at least the same amount of lowland seeds of good quality in stock in order to be able to meet the increasing demand for Bureau seeds.

## SEED DISTRIBUTION.

Seventy-one thousand six hundred and twenty-four liters were distributed during the year in the following manner:

| | Liters. |
|---|---|
| Sold: | |
| Upland | 31,575 |
| Lowland | 19,687 |
| Gratis, mostly to coöperators: | |
| Upland | 10,950 |
| Lowland | 6,787 |
| Lowland, bearded | 2,625 |
| Total | 71,624 |

## CORN.

The most important phase of the corn work was the production of good seed at the La Carlota Station for use in our seed-distribution propaganda. The improved white native corn which is more often incorrectly called Moro corn has been produced in considerable quantities during the year and approximately 400 bushels of selected seed have been received to date from the station. A large quantity of corn rejected for seed purposes was utilized for feeding animals at the station.

Aside from the seed-production work, several ear-to-the-row tests have been conducted with a number of native yellow varieties of corn at both the La Carlota and Singalong stations.

Among the varieties tested were Laguna yellow, Lobo yellow, Cagayan yellow, and Cagayan mixed.

This test consisted of a given number of rows each planted with a selected ear of some particular variety. The corn plants were thinned while still young, so as to give the remaining choice plants the full benefit of the space necessary for their proper development. In order that cross fertilization might be assured, one-half of each row, alternating halves, was detasseled, care being used that the detasseling was done before the pollen was ripe. At maturity the corn was harvested and the best individual ears selected for further work along the same lines.

Results thus far obtained indicate that the Laguna and Lobo yellow varieties are nearly on a par in regard to yield. The Lobo variety, however, is somewhat earlier maturing.

### CANE VARIETIES.

By far the greater part of the sugar cane grown here is of the purple variety. In the Island of Negros this is known as the Negros purple or "Morado" variety, in Cebu the Cebu purple, and in Pampanga the Pampanga purple.

White cane is grown to some extent in the Island of Luzon and is known under the name of Luzon white, Laguna white, Pampanga white, or Zambales white, depending upon the location where the cane was grown. While these varieties differ slightly in their characteristics of growth yet this difference is due largely to the varied conditions under which the cane was grown rather than to their being distinct varieties.

In adition to the native varieties, during the past two years this Bureau has introduced one or more of the following foreign varieties into practically every sugar-producing province of the Archipelago: Hawaiian seedlings Nos. 16, 20, 27, 69, 227, 309, Lahaina, Louisiana Striped, Demerara 1135, Yellow Caledonia.

Before any of these varieties were distributed to the planters they were grown at the experiment stations for a number of years under careful observation in order to make sure that each variety was absolutely free from fungus growth and other cane diseases. Since the year 1913 careful chemical tests have been made of the cane each week, beginning one month before the harvest period and extending to one month beyond that time.

When it has been thoroughly demonstrated to the satisfaction of this Bureau that the new variety is superior to those in common use the distribution of points to the planters is begun.

Many of these varieties have done so well under conditions

here and have found such favor among the planters that requests have been received for the cuttings far in excess of the available supply, notwithstanding the fact that a number of hectares of land were planted to cane at the La Carlota and Alabang experiment stations for the purpose of supplying the planters. During the past year upward of a hundred thousand cane points were distributed through this office.

### PHILIPPINE SEEDLING VARIETIES.

The importance of employing superior varieties of cane has been recognized for some time, and three years ago work of producing seedling varieties from the best cane then in use was started. Seed was accordingly secured from a number of both foreign and native varieties of cane growing at the Alabang Experiment Station. These were planted in boxes at the propagation sheds of the Singalong Experiment Station and a great number of young plants were started. Unfortunately, however, these plants were mistaken for grass by the workmen in charge of cleaning the beds, and were destroyed.

During the succeeding year another lot of plants were started, but these met a similar fate. Last year special precautions were taken to protect the plants with the result that 108 variants were produced. The cane from which these seeds were obtained was the Louisiana Striped, Lahaina, Rose Bamboo, Hawaii 20 and 27. The new varieties were numbered consecutively beginning with P. I. No. 1.

During the forepart of November this work was started for the present season. The flowers of each variety were carefully examined to determine their supply of normal pollen. Many of the flowers of an arrow of a proven variety were then emasculated and pollen brought in from the flowers of another variety possessing desireable qualities. These flowers were then inclosed in wire cages covered with cloth or paraffine paper. The hybrid seed thus secured was planted in boxes at the Singalong Experiment Station. The young plants will be transplanted, when large enough, to the cane plot at that station and each will be given a number starting with P. I. No. 109.

### LA CARLOTA EXPERIMENT STATION.

Approximately 4 hectares of cane were grown at this station, consisting of the following varieties: Inalmon, Negros Purple, Luzon White, Cebu Purple, Pampanga Purple, and Tigbao Mestiza, as well as the following foreign varieties: Hawaii Nos. 16, 20, 27, 69, 227, and 309, Rose Bamboo, Lahaina, Yellow

Caledonia, Demerara 95, 1135, Louisiana Striped, Louisiana Purple, Badila or N. G. 15, N. G. 24, 24–A, 24–B, 40, Barbados 3141, Mauritius 1900, Mauritius Malagache, Malabar Cheribon, Otomato or Striped Cheribon, L 426, 426 (sport) and Big Tanna.

This cane was used in determining analytical and tonnage data on the different varieties, and in furnishing points for distribution purposes.

The sugar laboratory at this place has been in operation since the latter part of 1913.

Weekly analyses of the different varieties were made during the first two years the laboratory was operated. The following report, showing the composition of the different varieties of cane, has been compiled with a view of showing the superior varieties:

*Report of sugar analyses at the sugar laboratory, Isabela, Occidental Negros.*

[Analyzed by, F. Subang; Officer in charge, C. W. Hines.]

FOR THE WEEK ENDING FEBRUARY 21, 1916.

| Product. | Where secured. | Cane variety. | Cane. | | Juice. | | | | | Sucrose extraction. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sucrose. | Fiber. | Total solid. | Sucrose. | Purity. | Invert sugar. | Acid, N/28 alk. | | |
| Cane | Hacienda Progreso | Negros Purple | 12.1 | 10.0 | 15.87 | 13.28 | 83.7 | 1.06 | *c. c.* 16.5 | 95.5 | |
| Do | do | do | | | 19.10 | 17.00 | 88.0 | 0.47 | 18.0 | 95.5 | |
| Do | do | do | 13.8 | 10.3 | 19.40 | 17.16 | 88.5 | 1.01 | 30.1 | 95.5 | |
| Do | Hacienda Tres Hermanos | do | | | 21.20 | 18.82 | 88.8 | .60 | 29.0 | 95.5 | |
| Do | do | do | | | 19.00 | 16.37 | 86.2 | .40 | 27.0 | 95.5 | |
| Do | Hacienda Carmaling | do | 13.6 | 10.8 | 20.81 | 18.52 | 89.0 | .30 | 29.0 | 95.5 | |
| Do | Hacienda Constancia | do | | | 18.50 | 16.00 | 86.9 | .27 | 32.0 | 95.5 | |
| Do | do | do | | | 17.71 | 15.40 | 87.1 | .21 | 27.0 | 95.5 | |
| Do | do | do | | | 18.40 | 16.06 | 87.3 | .35 | 37.5 | 95.5 | |
| Do | do | Hawaii 16 | 11.9 | 9.9 | 16.01 | 12.66 | 79.1 | .21 | 40.0 | 95.5 | |
| Sugar 2 | Magdalena Central | Negros Purple | | | | | | | | | 93.7° direct polarization. |
| Sugar 1 | do | do | | | | | | | | | 95.5° direct polarization. |
| Cane | do | do | 10.2 | 9.7 | 16.1 | 12.51 | 79.2 | | | 95.5 | |
| Juice | do | do | | | 16.17 | 12.6 | 78.5 | | | | First mill juice. |
| Do | do | do | | | 16.43 | 12.8 | 78.1 | | | | Second mill juice. |
| Do | do | do | | | 15.43 | 11.8 | 77.1 | | | | Third mill juice. |
| Do | do | do | | | 15.63 | 12.1 | 77.6 | | | | Mixed juice. |
| Do | do | do | | | 15.97 | 13.2 | 83.2 | | | | Clarified juice from previous cane. |
| Do | do | Inalmon | 14.0 | 10.9 | 19.00 | 17.1 | 90.0 | .64 | | 95.5 | |

FOR THE WEEK ENDING FEBRUARY 26, 1916.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | c. c. | | |
| Cane | Hacienda San Nicolas | Negros Purple | 13.2 | 10.2 | 19.4 | 17.0 | 88.1 | | | 95 | |
| Do | do | do | 12.8 | 10.7 | 20.9 | 17.0 | 88.9 | | | | |
| Sugar | do | do | | | | | | | | | 86.4 direct polarization. |
| Do | Hacienda Montelibano | do | | | | | | | | | 84.6 direct polarization. |
| Do | do | do | | | | | | | | | 79.0 direct polarization. |
| Do | do | do | | | | | | | | | 68.0 direct polarization. |
| Cane | do | do | 13.1 | 11.1 | 18.2 | 15.7 | 87.1 | 0.40 | 36.5 | | |
| Do | do | do | 12.4 | 10.3 | 18.1 | 15.5 | 86.7 | .43 | 32.5 | | 83.8 direct polarization. |
| Sugar | Hacienda Alicante | do | | | | | | | | | 83.0 direct polarization. |
| Do | do | do | | | | | | | | | 82.9 direct polarization. |
| Do | do | do | | | | | | | | | |
| Cane | do | do | | | 19.4 | 17.2 | 88.6 | .36 | 32.1 | | |
| Do | do | do | | | 21.9 | 19.4 | 88.8 | .37 | 27.0 | | |
| Do | do | do | 12.7 | 9.9 | 21.4 | 18.8 | 87.9 | .39 | 29.0 | | |
| Do | do | do | | | 19.9 | 16.4 | 82.6 | .43 | 40.1 | | |
| Do | do | do | 13.0 | 10.2 | 21.6 | 18.1 | 84.1 | .51 | 32.1 | | |
| Do | Hacienda Nalipay | do | | | 17.5 | 14.2 | 80.1 | 1.20 | 48.0 | | |
| Do | do | do | | | 18.4 | 15.5 | 84.2 | .70 | 37.1 | | |
| Do | do | do | 13.3 | 10.6 | 19.3 | 17.1 | 88.8 | .50 | 32.0 | | |
| Do | do | do | | | 19.7 | 17.3 | 88.2 | .22 | 30.1 | | |

*Report of sugar analyses at the sugar laboratory, Isabela, Occidental Negros*—Continued.

FOR THE WEEK ENDING MARCH 4, 1916.

| Product. | Where secured. | Cane variety. | Cane. Sucrose. | Cane. Fiber. | Juice. Total solid. | Juice. Sucrose. | Juice. Purity. | Juice. Invert sugar. | Juice. Acid, N/28 alk. | Sucrose extraction. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cane | Hacienda Montelibano | Negros Purple | | | 16.6 | 13.47 | 81.2 | 0.60 | c. c. 43.0 | 95 | |
| Do | do | do | 9.9 | 10.7 | 17.1 | 13.58 | 85.2 | .91 | 31.0 | 95 | |
| Do | do | do | | | 21.6 | 19.02 | 88.1 | .41 | 32.0 | 95 | |
| Do | do | do | | | 21.1 | 18.64 | 88.6 | .54 | 27.0 | 95 | |
| Do | Hacienda Tres Hermanos | do | 10.6 | 10.9 | 14.5 | 11.16 | 77.0 | 1.42 | 31.5 | 95 | Cane 4 meters long, new land. |
| Do | do | do | 13.8 | 10.0 | 20.5 | 18.08 | 88.2 | | | | |
| Do | do | do | | | 17.2 | 14.27 | 83.0 | | | | |
| Juice | do | do | | | 20.8 | 18.53 | 89.1 | | | | |
| Sugar | do | do | 10.9 | 9.7 | 16.7 | 12.34 | 73.9 | | | | 83.8 direct polarization. |
| Cane | Hacienda Enriqueta | do | | | 21.5 | 19.13 | 89.0 | 1.43 | 30.1 | 95 | |
| Do | do | do | | | 22.1 | 19.69 | 89.1 | .48 | 29.1 | 95 | |
| Do | do | do | 13.9 | 10.4 | 21.9 | 19.46 | 88.9 | .38 | 40.2 | 95 | |
| Sugar | do | do | | | | | | | | | 89.6 direct polarization. |
| Do | do | do | | | | | | | | | 87.0 direct polarization. |
| Do | Hacienda Nalipay | do | | | | | | | | | 75.6 direct polarization. |
| Do | do | do | | | | | | | | | 86.4 direct polarization. |
| Do | do | do | | | | | | | | | 84.2 direct polarization. |
| Cane | do | do | 11.7 | 9.8 | 17.43 | 13.96 | 80.1 | 1.10 | 33.5 | 95 | |
| Do | do | do | 13.8 | 10.9 | 21.83 | 19.42 | 84.4 | .56 | 41.5 | 95 | |
| Do | do | do | | | 20.03 | 18.10 | 89.2 | .57 | 27.5 | 95 | |
| Do | do | do | 13.4 | 10.5 | 20.13 | 17.63 | 87.6 | .61 | 45.6 | 95 | |

FOR THE WEEK ENDING MARCH 12, 1916.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cane | Hacienda Remigio | Negros Purple | 13.9 | 10.4 | 21.57 | 19.26 | 89.3 | 0.71 | *c. c.* 62.5 | 95.5 | First ratoon one year old. |
| Do | Hacienda Enriqueta | do | 12.8 | 9.6 | 16.53 | 13.24 | 80.1 | 1.43 | 60.5 | 95.5 | Cane 12 months, very large. |
| Do | do | do | 13.7 | 11.1 | 21.33 | 19.17 | 89.9 | .48 | 31.5 | 95.5 | Cane 14 months old. |
| Do | do | do | 14.2 | 11.2 | 21.93 | 19.66 | 89.7 | .38 | 33.5 | 95.5 | Cane 13 months old. |
| Do | do | do | 14.0 | 10.9 | 21.73 | 19.40 | 89.3 | .56 | 30.2 | 95.5 | Do. |
| Sugar | do | do | | | | | | | | | 87 polarization. |
| Do | do | do | | | | | | | | | 75.6 polarization made during rains. |
| Do | Hacienda Alicante | do | | | | | | | | | 86.4 polarization from good cane, juice well clarified. |
| Cane | Hacienda Nalipay | do | 13.0 | 11.1 | 17.43 | 14.46 | 82.5 | .56 | 34.3 | 95.5 | Plant cane one year old. |
| Do | do | do | 14.0 | 11.4 | 21.83 | 18.87 | 86.5 | 1.06 | 37.2 | 95.5 | First ratoon mature. |
| Do | do | do | 13.9 | 10.5 | 20.03 | 18.47 | 90.1 | .40 | 31.1 | 95.5 | Cane 14 months old and very good. |
| Do | Hacienda San Beñito | do | 12.6 | 10.3 | 19.80 | 15.69 | 88.2 | .71 | 40.0 | 95.5 | Plant cane grown on old cane land. |
| Do | do | do | 12.9 | 9.9 | 20.50 | 17.01 | 83.0 | .59 | 50.0 | 95.5 | Plant cane one year. |
| Do | do | do | 12.2 | 9.8 | 18.60 | 15.86 | 85.3 | .78 | 72.1 | 95.5 | First ratoon cane one year. |
| Sugar | do | do | | | | | | | | | 81 polarization. |
| Cane | Hacienda Enriqueta | do | 13.1 | 10.7 | 21.27 | 18.96 | 89.2 | .41 | 47.2 | 95.5 | Plant cane 14 months old. |
| Do | do | do | 13.2 | 11.0 | 20.06 | 17.82 | 88.9 | .53 | 51.1 | 95.5 | Second ratoon cane. |
| Do | Hacienda Antolonga | do | 12.8 | 10.2 | 20.07 | 17.77 | 88.6 | .43 | 42.0 | 95.5 | Second ratoon. |
| Do | do | do | 14.6 | 11.2 | 22.07 | 19.65 | 89.1 | .37 | 36.0 | 95.5 | Plant cane 13 months, mature. |
| Do | Hacienda Dresden | do | 13.8 | 10.5 | 19.10 | 16.78 | 87.9 | .60 | 47.0 | 95.5 | Plant cane 14 months old. |
| Sugar | do | do | | | | | | | | | 81.6 made during rains. |
| Cane | Hacienda Remigio | do | 11.6 | 10.0 | 15.40 | 12.08 | 78.5 | 1.32 | 42.0 | 95.5 | Plant cane, 12 months, low rich land. |
| Do | do | do | 13.4 | 10.7 | 19.33 | 17.06 | 88.3 | .60 | 40.1 | 95.5 | Plant cane 14 months, old land. |
| Do | Hacienda Santo Domingo | do | 14.0 | 10.3 | 20.87 | 18.93 | 88.9 | .69 | 31.1 | 95.5 | First ratoon 14 months. |
| Do | do | do | 12.7 | 9.8 | 16.67 | 12.25 | 73.5 | 1.20 | 72.0 | 95.5 | Plant cane, very rich land, cane 3 months old. |

*Report of sugar analyses at the sugar laboratory, Isabela, Occidental Negros*—Continued.

FOR THE WEEK ENDING MARCH 19, 1916.

| Product. | Where secured. | Cane variety. | Cane. | | Juice. | | | | | Sucrose extraction. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sucrose. | Fiber. | Total solid. | Sucrose. | Purity. | Invert sugar. | Acid. N/28 alk. | | |
| | | | | | | | | | c. c. | | |
| Cane | Hacienda Dos Hermanos | Negros Purple | 14.1 | 10.2 | 21.77 | 20.08 | 92.3 | | 59.5 | 95.5 | Plant cane 13 months old. |
| Do | do | do | 14.3 | 9.7 | 21.97 | 20.47 | 93.7 | | 37.5 | 95.5 | First ratoon cane one year. |
| Sugar | Hacienda San Jose | do | | | | | | | | | 89.1 direct polarization. |
| Cane | Hacienda Dos Hermanos | do | 13.7 | 10.5 | 22.24 | 20.36 | 91.6 | | 39.0 | 95.5 | Second ratoon one year old. |
| Do | do | do | 20.0 | | 21.54 | 19.49 | 90.5 | | 26.0 | 95.5 | Plant Cane one year old. |
| Do | Hacienda Bongahin | do | 13.0 | 11.2 | 16.10 | 13.19 | 81.9 | 0.40 | 38.0 | 95.5 | First ratoon cane. |
| Do | do | do | 13.3 | 11.0 | 18.80 | 16.36 | 87.1 | .48 | 23.0 | 95.5 | Plant cane 14 months old. |
| Sugar | do | do | | | | | | | | | 83.9 direct polarization. |
| Do | do | do | | | | | | | | | 81.5 direct polarization. |
| Cane | Hacienda Adela | do | 13.8 | 10.9 | 21.61 | 19.21 | 89.2 | | 35.0 | 95.5 | Duplicate run. |
| Do | do | do | 14.6 | 9.7 | 21.31 | 19.65 | 92.2 | | 37.5 | 95.5 | Triplicate run. |
| Sugar | do | do | | | | | | | | | 87.4 direct polarization. |
| Cane | Hacienda Dos Hermanos | do | 13.1 | 10.6 | 21.99 | 19.34 | 88.0 | .40 | 26.5 | 95.5 | First ratoon, 14 months. |
| Do | do | do | 13.9 | 10.2 | 23.59 | 21.32 | 90.4 | .32 | 27.0 | 95.5 | Plant cane, 12 months. |
| Do | do | do | 14.0 | 10.4 | 20.94 | 20.60 | 88.4 | .43 | 34.0 | 95.5 | Do. |
| Do | do | do | 13.1 | 9.9 | 18.14 | 16.03 | 87.2 | .36 | 38.0 | 95.5 | Plant cane, 13 months. |
| Sugar | do | do | | | | | | | | | 89.65 direct polarization. |
| Cane | Hacienda Pocatud | do | 13.8 | 10.6 | 21.77 | 19.60 | 90.6 | .43 | 26.0 | 95.5 | 16 months, duplicate run. |
| Do | do | do | 14.6 | 10.1 | 21.77 | 20.11 | 92.4 | .36 | 57.0 | 95.5 | 15 months, triplicate run. |
| Do | do | do | 13.7 | 10.7 | 20.57 | 18.34 | 90.5 | | 42.5 | 95.5 | 14 months, triplicate run. |
| Do | do | do | 14.7 | 9.2 | 19.97 | 18.67 | 93.5 | | 25.5 | 95.5 | Do. |
| Sugar | do | do | | | | | | | | | 89.8 direct polarization. |
| Cane | Hacienda Carmaling | do | 13.0 | 11.0 | 19.07 | 15.94 | 82.6 | .48 | 66.0 | 95.5 | Plant cane, 12 months. |

FOR THE WEEK ENDING MARCH 28, 1916.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | c. c. | | |
| Cane | Hacienda Montelibano | Negros Purple | 14.0 | 10.6 | 20.91 | 19.28 | 92.2 | 0.47 | 31.0 | 95.5 | Mature cane. |
| Do | do | do | 14.5 | 10.4 | 22.34 | 20.89 | 93.5 | .61 | 46.5 | 95.5 | Cane 13 months old. |
| Sugar | do | do | | | | | | | | | 83.4° direct polarization. |
| Do | Hacienda Dos Hermanos | do | | | | | | | | | 86.2° direct polarization. |
| Do | Hacienda Camangcamang | do | | | | | | | | | 86.0° direct polarization. |
| Do | do | do | | | | | | | | | 70.0° direct polarization. |
| Cane | Hacienda Concordia | do | 13.6 | 10.0 | 21.19 | 19.16 | 90.4 | | 28.5 | 95.5 | Cane 15 months old. |
| Sugar | do | do | | | | | | | | | 85.8° direct polarization. |
| Cane | Hacienda Dos Hermanos | do | 14.0 | 10.7 | 20.31 | 18.40 | 90.6 | | 34.5 | 95.5 | |
| Sugar | Hacienda Alicante | do | | | | | | | | | 80.0° direct polarization. |
| Cane | Hacienda Carmaling | do | 10.3 | 9.4 | 15.07 | 11.83 | 78.5 | .39 | 61.5 | 95.5 | |
| Do | Hacienda Josefa | do | 14.0 | 10.5 | 20.71 | 18.29 | 88.3 | .32 | 54.5 | 95.5 | Cane from rich land. |
| Do | do | do | 13.6 | 10.2 | 19.81 | 17.51 | 88.4 | .36 | 49.0 | 95.5 | Do. |
| Do | do | do | 14.0 | 11.4 | 21.61 | 19.58 | 90.6 | .52 | 34.0 | 95.5 | Cane 13 months old. |
| Do | do | do | 13.7 | 11.2 | 20.64 | 18.72 | 90.7 | .49 | 25.5 | 95.5 | Mature cane. |
| Do | Hacienda Nalipay | do | 13.2 | 10.9 | 20.90 | 18.02 | 86.2 | .54 | 44.5 | 95.5 | Cane 14 months old. |
| Do | do | do | 12.9 | 10.2 | 21.60 | 18.12 | 83.9 | .41 | 56.0 | 95.5 | Cane 12½ months old. |
| Do | do | do | 13.3 | 10.8 | 19.50 | 16.83 | 86.3 | .43 | 28.5 | 95.5 | Cane 13 months old. |
| Do | Hacienda Progreso | do | 14.0 | 10.6 | 21.84 | 19.61 | 89.8 | .61 | 42.5 | 95.5 | Cane 14 months old. |
| Do | do | do | 13.9 | 10.9 | 21.47 | 19.15 | 89.2 | .29 | 37.0 | 95.5 | Cane 14 months old. |
| Sugar | do | do | | | | | | | | | 83.0° direct polarization. |
| Cane | Hacienda Constancia | do | 12.9 | 9.7 | 17.09 | 14.83 | 86.8 | .39 | 47.5 | 95.5 | Cane 12 months old. |
| Do | do | do | 12.4 | 10.6 | 17.79 | 15.26 | 85.8 | .40 | 41.5 | 95.5 | Cane 12 months old. |
| Do | do | do | 14.6 | 11.4 | 21.71 | 19.81 | 91.3 | .32 | 37.5 | 95.5 | Cane 13 months old. |
| Do | do | do | 13.9 | 11.2 | 21.74 | 19.89 | 91.5 | .35 | 38.0 | 95.5 | Cane 12 months old. |

*Report of sugar analyses at the sugar laboratory, Isabela, Occidental Negros*—Continued.

FOR THE WEEK ENDING APRIL 8, 1916.

| Product. | Where secured. | Cane variety. | Cane. | | Juice. | | | | | Sucrose extraction. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sucrose. | Fiber. | Total solid. | Sucrose. | Purity. | Invert sugar. | Acid, N/28 alk. | | |
| | | | | | | | | | *c. c.* | | |
| Cane | Hacienda Enriqueta | Negros Purple | 13.8 | 10.4 | 20.51 | 18.40 | 89.7 | | 37.5 | 95.5 | Cane 16 months old. |
| Do | do | do | 13.3 | 10.1 | 17.91 | 15.44 | 86.2 | 0.47 | 26.5 | 95.5 | Do. |
| Do | do | do | 14.6 | 10.7 | 20.71 | 18.68 | 90.2 | | 33.5 | 95.5 | |
| Sugar | do | do | | | | | | | | | 85.8° direct polarization. |
| Do | do | do | | | | | | | | | 88.8° direct polarization. |
| Do | do | do | | | | | | | | | 76.6° direct polarization. |
| Do | Hacienda San Nicolas | do | | | | | | | | | 82.8° direct polarization. |
| Do | do | do | | | | | | | | | 87.4° direct polarization. |
| Cane | Hacienda San Jose | do | 12.6 | 9.9 | 17.51 | 14.99 | 85.6 | .35 | 59.0 | 95.5 | Cane 12 months old. |
| Do | do | do | 13.4 | 10.1 | 17.71 | 14.95 | 84.4 | | 41.0 | 95.5 | Do. |
| Sugar | do | do | | | | | | | | | 82.6° direct polarization. |
| Do | do | do | | | | | | | | | 82.8° direct polarization. |
| Cane | Hacienda San Joaquin | do | 14.0 | 10.3 | 19.33 | 17.47 | 90.4 | | 44.5 | 95.5 | Cane 12 months old. |
| Do | do | do | 14.6 | 10.6 | 21.03 | 18.99 | 90.3 | | 52.5 | 95.5 | Do. |
| Sugar | do | do | | | | | | | | | 87.2° direct polarization. |
| Do | do | do | | | | | | | | | 83.2° direct polarization. |
| Do | do | do | | | | | | | | | 81.2° direct polarization. |
| Cane | Hacienda Concordia | do | 13.9 | 10.1 | 20.04 | 18.04 | 90.0 | | | 95.5 | |
| Sugar | do | do | | | | | | | | | 83.0° direct polarization. |
| Do | do | do | | | | | | | | | 79.4° direct polarization. |
| Do | Hacienda Dos Hermanos | do | | | | | | | | | 81.0° direct polarization. |
| Do | Hacienda Adela | do | | | | | | | | | 90.2° direct polarization. |
| Cane | do | do | 13.8 | 9.9 | 19.61 | 17.43 | 88.9 | | 54.0 | 95.5 | Cane 12 months old. |
| Do | do | do | 14.3 | 9.8 | 20.81 | 19.08 | 91.7 | | 56.0 | 95.5 | Cane 15 months old. |
| Do | Hacienda Pilar | do | 14.0 | 10.4 | 18.71 | 15.88 | 84.9 | .35 | 41.5 | 95.5 | |

FOR THE WEEK ENDING APRIL 13, 1916.

| | | | | | | | | | c. c. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sugar | Hacienda Adela | Negros Purple | | | | | | | | | 82.4° direct polarization. |
| Do | do | do | | | | | | | | | 80.4° direct polarization. |
| Do | Hacienda Santo Domingo | do | | | | | | | | | 79.4° direct polarization. |
| Do | do | do | | | | | | | | | 78.0° direct polarization. |
| Cane | Hacienda Alicante | do | 14.4 | 10.6 | 21.91 | 19.48 | 88.9 | 0.56 | 50.0 | 95.5 | |
| Do | do | do | 13.9 | 10.4 | 20.71 | 17.50 | 84.5 | .62 | 57.0 | 95.5 | |
| Do | Hacienda Pilar | do | 10.7 | 9.9 | 16.41 | 11.60 | 70.7 | .52 | 62.5 | 95.5 | |
| Do | Hacienda Constancia | do | 13.0 | 10.4 | 20.11 | 18.99 | 90.0 | .32 | 56.5 | 95.5 | Cane 15 months old. |
| Do | do | do | 13.6 | 10.6 | 19.61 | 17.26 | 88.0 | .34 | 43.5 | 95.5 | Cane 14 months old. |
| Sugar | do | do | | | | | | | | | 78.2° direct polarization. |
| Do | do | do | | | | | | | | | 67.4° direct polarization. |
| Do | do | do | | | | | | | | | 86.2° direct polarization. |
| Do | do | do | | | | | | | | | 86.8° direct polarization. |
| Do | Hacienda Montelibano | do | | | | | | | | | 78.8° direct polarization. |
| Do | do | do | | | | | | | | | 81.2° direct polarization. |
| Do | do | do | | | | | | | | | 83.6° direct polarization. |
| Do | do | do | | | | | | | | | 82.6° direct polarization. |
| Do | do | do | | | | | | | | | Do. |
| Do | do | do | | | | | | | | | 71.4° direct polarization. |

*Report of sugar analyses at the sugar laboratory, Isabela, Occidental Negros*—Continued.

FOR THE WEEK ENDING APRIL 19, 1916.

| Product. | Where secured. | Cane variety. | Cane. | | Juice. | | | | | Sucrose extraction. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sucrose. | Fiber. | Total solid. | Sucrose. | Purity. | Invert sugar. | Acid, N/28 alk. | | |
| | | | | | | | | | c. c. | | |
| Sugar | Hacienda Montelibano | Negros Purple | | | | | | | | | 72.0° direct polarization. |
| Cane | do | do | 14.83 | 10.11 | 18.11 | 14.67 | 81.0 | 0.43 | 45.0 | 95.5 | |
| Sugar | Hacienda Santo Domingo | do | | | | | | | | | 75.6° direct polarization. |
| Do | Hacienda Carmiling | do | | | | | | | | | 71.8° direct polarization. |
| Do | do | do | | | | | | | | | 73.0° direct polarization. |
| Do | do | do | | | | | | | | | 79.4° direct polarization. |
| Cane | Hacienda Dos Hermanos | do | 13.40 | 11.2 | 20.17 | 18.07 | 89.6 | | 35.0 | 95.5 | |
| Sugar | do | do | | | | | | | | | 84.2° direct polarization. |
| Do | do | do | | | | | | | | | 72.6° direct polarization. |
| Do | Hacienda Montelibano | do | | | | | | | | | 80.8° direct polarization. |
| Do | Hacienda San Benito | do | | | | | | | | | 85.5° direct polarization. |
| Cane | Hacienda Santo Domingo | do | 13.7 | | 20.67 | 18.35 | 88.8 | .32 | 71.5 | 95.5 | |
| Sugar | Hacienda San Benito | do | | | | | | | | | 77.4° direct polarization. |
| Do | do | do | | | | | | | | | 79.4° direct polarization. |
| Cane | Hacienda Progreso | do | 13.2 | | 20.37 | 17.86 | 87.7 | .35 | 53.5 | 95.5 | Cane 15 months old. |
| Do | do | do | 14.5 | | 20.74 | 18.23 | 87.9 | .33 | 42.5 | 95.5 | Cane 13 months old. |
| Sugar | do | do | | | | | | | | | 81.6° direct polarization. |
| Cane | Hacienda Carmiling | do | 12.95 | | 19.11 | 16.76 | 87.7 | .53 | 37.0 | 95.5 | Cane 13 months old. |
| Do | do | do | 13.7 | | 20.21 | 18.49 | 91.5 | | 40.0 | 95.5 | Cane 14 months old. |
| Sugar | Hacienda Camangcamang | do | | | | | | | | | 77.0° direct polarization. |
| Do | do | do | | | | | | | | | 72.8° direct polarization. |
| Cane | do | do | 17.86 | | 19.71 | 17.58 | 89.2 | .32 | 42.5 | 95.5 | |
| Do | Hacienda Santo Domingo | do | 16.47 | 11.7 | 19.11 | 16.28 | 85.2 | .40 | 42.5 | 95.5 | Cane 17 months old. |
| Do | do | do | 12.72 | 10.4 | 16.81 | 12.59 | 74.9 | .32 | 35.0 | 95.5 | |
| Sugar | do | do | | | | | | | | | 76.4° direct polarization. |
| Do | do | do | | | | | | | | | 76.2° direct polarization. |
| Cane | Hacienda Dos Hermanos | do | 16.74 | | 18.79 | 16.63 | 88.5 | .48 | 45.0 | 95.5 | |
| Do | Hacienda Constancia | do | 18.8 | | 20.81 | 18.62 | 89.5 | .41 | 31.5 | 95.5 | |

FOR THE WEEK ENDING MAY 2, 1916.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | c. c. | | |
| Sugar | Hacienda Montelibano | Negros Purple | | | | | | | | | 75.8° direct polarization. |
| Do | do | do | | | | | | | | | 75.3° direct polarization. |
| Do | Hacienda Constancia | do | | | | | | | | | 80.6° direct polarization. |
| Do | do | do | | | | | | | | | 81.6° direct polarization. |
| Do | Hacienda Carmaling | do | | | | | | | | | 81.0° direct polarization. |
| Cane | do | do | 13.0 | | 20.83 | 17.68 | 84.9 | 0.48 | 40.5 | 95.5 | One year old. |
| Do | do | do | 11.9 | | 19.23 | 15.31 | 79.6 | .54 | 45.5 | 95.5 | Over mature. |
| Sugar | Hacienda Nalipay | do | | | | | | | | | 71.2° direct polarization. |
| Do | do | do | | | | | | | | | 79.8° direct polarization. |
| Do | do | do | | | | | | | | | 77.8° direct polarization. |
| Do | do | do | | | | | | | | | 73.4° direct polarization. |
| Cane | do | do | 11.4 | | 17.77 | 14.29 | 80.4 | .43 | 43.5 | 95.5 | |
| Sugar | Hacienda Montelibano | do | | | | | | | | | 81.6° direct polarization. |
| Do | do | do | | | | | | | | | 80.2° direct polarization. |
| Do | do | do | | | | | | | | | 83.4° direct polarization. |
| Do | do | do | | | | | | | | | 81.2° direct polarization. |
| Do | do | do | | | | | | | | | 73.6° direct polarization. |
| Do | do | do | | | | | | | | | 76.2° direct polarization. |
| Do | do | do | | | | | | | | | 82.0° direct polarization. |
| Do | Hacienda Carmaling | do | | | | | | | | | 76.2° direct polarization. |
| Do | do | do | | | | | | | | | 68.4° direct polarization. |
| Do | Hacienda Constancia | do | | | | | | | | | 79.0° direct polarization. |
| Do | do | do | | | | | | | | | 82.0° direct polarization. |
| Do | do | do | | | | | | | | | 81.8° direct polarization. |
| Do | do | do | | | | | | | | | 79.6° direct polarization. |

*Report of sugar analyses at the sugar laboratory, Isabela, Occidental Negros*—Continued.

FOR THE WEEK ENDING MAY 13, 1916.

| Product. | Where secured. | Cane variety. | Cane. | | Juice. | | | | | Sucrose extraction. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sucrose. | Fiber. | Total solid. | Sucrose. | Purity. | Invert sugar. | Acid, N/28 alk. | | |
| | | | | | | | | | *c. c.* | | |
| Cane | Hacienda Santo Rosario | Negros Purple | 13.2 | 11.4 | 19.30 | 15.53 | 80.5 | 0.44 | 57.5 | 95.5 | Slightly over mature. |
| Do | do | do | 12.6 | 11.7 | 18.30 | 14.49 | 79.2 | .46 | 48.5 | 95.5 | Do. |
| Do | do | do | 12.8 | | 17.20 | 12.95 | 75.3 | .52 | 41.5 | 95.5 | Over mature cane. |
| Sugar | do | do | | | | | | | | | 79.0° direct polarization. |
| Do | Hacienda Josefa | do | | | | | | | | | 80.8° direct polarization. |
| Do | do | do | | | | | | | | | 79.6° direct polarization. |
| Do | do | do | | | | | | | | | 72.4° direct polarization. |
| Cane | Hacienda Progreso | do | 12.9 | | 20.67 | 15.89 | 76.9 | .34 | 60.5 | 95.5 | Over mature cane. |
| Do | do | do | 13.7 | | 20.37 | 17.74 | 87.2 | | 47.0 | 95.5 | |
| Do | Hacienda Nalipay | do | 12.8 | | 19.37 | 16.73 | 86.4 | .33 | 46.0 | 95.5 | |
| Do | do | do | 12.6 | | 18.27 | 15.62 | 85.5 | | 42.5 | 95.5 | |
| Sugar | do | do | | | | | | | | | 78.6° direct polarization. |
| Do | do | do | | | | | | | | | 74.0° direct polarization. |
| Do | do | do | | | | | | | | | 68.0° direct polarization. |
| Do | Hacienda Montelibano | do | | | | | | | | | 69.2° direct polarization. |
| Do | do | do | | | | | | | | | 72.8° direct polarization. |
| Do | do | do | | | | | | | | | 81.0° direct polarization. |
| Do | Hacienda Dos Hermanos | do | | | | | | | | | 81.6° direct polarization. |
| Cane | Hacienda Constancia | do | 13.0 | | 18.61 | 17.98 | 84.8 | | 40.0 | 95.5 | |
| Sugar | do | do | | | | | | | | | 79.6° direct polarization. |
| Do | Hacienda Montelibano | do | | | | | | | | | 72.6° direct polarization. |
| Do | do | do | | | | | | | | | 68.8° direct polarization. |
| Do | do | do | | | | | | | | | 70.2° direct polarization. |
| Do | do | do | | | | | | | | | 69.2° direct polarization. |
| Do | Hacienda Carmaling | do | | | | | | | | | 76.8° direct polarization. |

During the forepart of the present year when plans were under way for the construction of a Government sugar central in the Isabela district of Negros, at the request of the Sugar Central Board, the laboratory was moved to Isabela and weekly analyses were made of the cane from the different plantations. This work served a three-fold purpose, namely, to furnish reliable data on the composition of the cane in that district; to furnish the planters information on the condition of these different fields of cane, thus enabling them to harvest only mature cane; and to furnish the planters with analytical data on the condition of the various sugar-house products, thus showing them wherein the grade of sugar might be improved.

Reports were issued to each planter immediately upon the completion of the analysis of his product, and at the close of the work in June a set of each of the weekly reports was furnished each planter.

The following is a complete report of the work done in that laboratory:

*Average analyses of cane juices from varieties growing at the La Carlota Experiment Station, Occidental Negros, 1914–1915.*

[Extraction juice on cane 67 per cent.]

HAWAII 16.

| Month. | Weight of stalk. | Brix. | Sucrose. | Purity. | Glucose. |
|---|---|---|---|---|---|
| | *Kilos.* | | | | |
| October | 1.90 | 14.80 | 11.48 | 77.56 | 1.370 |
| November | 1.37 | 15.49 | 12.70 | 81.98 | 1.005 |
| December | 1.40 | 16.47 | 14.25 | 86.52 | 0.680 |
| January | 1.58 | 15.68 | 13.36 | 85.20 | 0.660 |
| February | 1.49 | 15.77 | 14.10 | 89.41 | 0.510 |
| March | 1.75 | 13.55 | 11.38 | 83.98 | 0.560 |
| April | 1.75 | 17.45 | 15.37 | 88.08 | 0.610 |

HAWAII 20.

| Month. | Weight of stalk. | Brix. | Sucrose. | Purity. | Glucose. |
|---|---|---|---|---|---|
| October | 1.77 | 16.70 | 13.98 | 83.71 | 0.806 |
| November | 1.48 | 18.90 | 16.35 | 86.50 | 0.640 |
| December | 1.33 | 18.40 | 15.95 | 86.68 | 0.580 |
| January | 1.61 | 16.66 | 14.40 | 86.43 | 0.476 |
| February | 1.43 | 14.80 | 13.35 | 90.20 | 0.500 |
| March | 1.44 | 14.80 | 12.20 | 82.43 | 0.660 |
| April | 1.38 | 16.85 | 14.50 | 86.05 | 0.420 |

HAWAII 27.

| Month. | Weight of stalk. | Brix. | Sucrose. | Purity. | Glucose. |
|---|---|---|---|---|---|
| October | 2.09 | 15.30 | 12.02 | 78.56 | 1.070 |
| November | 1.87 | 17.05 | 14.10 | 82.69 | 0.720 |
| December | 1.25 | 16.20 | 13.45 | 83.02 | 0.730 |
| January | 1.73 | 17.16 | 14.50 | 84.49 | 0.550 |
| February | 1.81 | 17.40 | 14.90 | 85.63 | 0.480 |
| March | 2.21 | 17.97 | 15.25 | 84.86 | 0.630 |
| April | 2.15 | 19.55 | 17.12 | 87.57 | 0.400 |

*Average analyses of cane juices from varieties growing at the La Carlota Experiment Station, Occidental Negros, 1914–1915*—Continued.

HAWAII 69.

| Month. | Weight of stalk. | Brix. | Sucrose. | Purity. | Glucose. |
|---|---|---|---|---|---|
| | *Kilos.* | | | | |
| October | 1.64 | 15.30 | 11.95 | 78.10 | 0.860 |
| November | 1.32 | 16.60 | 13.40 | 80.72 | 0.870 |
| December | 1.23 | 15.30 | 12.30 | 80.39 | 0.785 |
| January | 1.39 | 15.32 | 12.10 | 78.98 | 0.690 |
| February | 1.26 | 15.10 | 11.95 | 79.13 | 0.657 |
| March | 1.62 | 16.55 | 12.97 | 78.36 | 0.580 |
| April | 1.48 | 16.10 | 13.07 | 81.18 | 0.245 |

HAWAII 227.

| | | | | | |
|---|---|---|---|---|---|
| October | 1.61 | 15.86 | 12.34 | 77.17 | 0.950 |
| November | 1.63 | 17.37 | 14.40 | 83.47 | 0.717 |
| December | 1.16 | 17.00 | 11.20 | 65.88 | 0.660 |
| January | 1.38 | 16.90 | 14.20 | 84.02 | 0.440 |
| February | 1.40 | 17.37 | 14.90 | 85.78 | 0.470 |
| March | 1.61 | 17.70 | 14.90 | 84.18 | 0.510 |
| April | 1.44 | 18.45 | 15.67 | 84.71 | 0.410 |

HAWAII 309.

| | | | | | |
|---|---|---|---|---|---|
| October | 2.35 | 16.57 | 13.68 | 82.55 | 0.886 |
| November | 2.14 | 17.67 | 15.05 | 85.11 | 0.75 |
| December | 1.94 | 17.07 | 14.35 | 84.06 | 0.62 |
| January | 2.20 | 17.45 | 15.20 | 87.10 | 0.45 |
| February | 1.79 | 17.70 | 16.35 | 92.37 | 0.43 |
| March | 2.00 | 18.50 | 15.15 | 81.89 | 0.40 |
| April | 2.33 | 17.60 | 15.42 | 87.73 | 0.35 |

LOUISIANA STRIPED.

| | | | | | |
|---|---|---|---|---|---|
| October | 1.53 | 17.08 | 14.24 | 83.37 | 0.920 |
| November | 1.25 | 18.70 | 16.40 | 87.70 | 0.468 |
| December | 1.32 | 18.82 | 16.80 | 89.26 | 0.370 |
| January | 1.42 | 18.90 | 16.88 | 89.31 | 0.398 |
| February | 1.23 | 19.95 | 16.70 | 83.70 | 0.400 |
| March | 1.20 | 19.75 | 17.17 | 86.93 | 0.690 |
| April | 1.25 | 20.07 | 17.90 | 89.18 | 0.440 |

YELLOW CALEDONIA.

| | | | | | |
|---|---|---|---|---|---|
| October | 2.00 | 15.44 | 11.70 | 75.77 | 1.210 |
| November | 1.83 | 16.70 | 13.65 | 81.73 | 0.810 |
| December | 1.26 | 16.35 | 13.25 | 81.03 | 0.730 |
| January | 1.54 | 17.10 | 13.85 | 80.99 | 0.620 |
| February | 1.36 | 18.40 | 15.47 | 80.07 | 0.510 |
| March | | | | | |
| April | 1.41 | 16.57 | 13.12 | 79.17 | 0.510 |

LAHAINA.

| | | | | | |
|---|---|---|---|---|---|
| October | 1.73 | 19.10 | 16.87 | 88.32 | 0.420 |
| November | 1.32 | 19.67 | 17.45 | 88.71 | 0.345 |
| December | 1.37 | 19.42 | 17.54 | 90.08 | 0.217 |
| January | 1.27 | 17.78 | 15.68 | 88.18 | 0.338 |
| February | 1.40 | 18.07 | 17.07 | 94.46 | 0.260 |
| March | 1.31 | 18.07 | 16.7 | 92.41 | 0.400 |
| April | 1.40 | 20.22 | 18.57 | 91.83 | 0.260 |

*Average analyses of cane juices from varieties growing at the La Carlota Experiment Station, Occidental Negros, 1914–1915*—Continued.

ROSE BAMBOO.

| Month. | Weight of stalk. | Brix. | Sucrose. | Purity. | Glucose. |
|---|---|---|---|---|---|
| | *Kilos.* | | | | |
| October | 1.46 | 16.48 | 14.00 | 84.95 | 0.740 |
| November | 1.47 | 17.20 | 14.20 | 82.55 | 0.510 |
| December | 1.15 | 15.90 | 14.80 | 93.08 | 0.540 |
| January | 1.46 | 16.30 | 14.00 | 85.88 | 0.410 |
| February | 1.50 | 16.37 | 14.50 | 88.57 | 0.420 |
| March | ------ | ------ | ------ | ------ | ------ |
| April | 1.41 | 19.05 | 17.37 | 91.18 | 0.260 |

YNALMON OR MANILA BLACK.

| | | | | | |
|---|---|---|---|---|---|
| October | 1.58 | 17.40 | 15.04 | 86.43 | 0.730 |
| November | 1.39 | 18.70 | 16.50 | 88.24 | 0.405 |
| December | 1.07 | 18.45 | 16.67 | 90.35 | 0.315 |
| January | 1.33 | 17.28 | 15.50 | 89.69 | 0.368 |
| February | 1.38 | 17.85 | 15.82 | 88.62 | 0.407 |
| March | 1.49 | 16.47 | 13.85 | 84.09 | 0.620 |
| April | 1.56 | 18.97 | 17.10 | 90.14 | 0.230 |

NEGROS PURPLE.

| | | | | | |
|---|---|---|---|---|---|
| October | 1.19 | 16.04 | 13.10 | 81.67 | 0.998 |
| November | 1.04 | 17.87 | 15.60 | 87.29 | 0.470 |
| December | 1.06 | 19.35 | 17.60 | 90.95 | 0.270 |
| January | 1.23 | 18.20 | 16.08 | 88.35 | 0.390 |
| February | 1.28 | 19.60 | 17.57 | 89.64 | 0.480 |
| March | 1.29 | 18.90 | 16.86 | 89.20 | 0.560 |
| April | 1.42 | 20.10 | 17.40 | 86.56 | 0.400 |

LUZON NO. 1.

| | | | | | |
|---|---|---|---|---|---|
| October | 1.32 | 13.88 | 10.60 | 76.36 | 1.290 |
| November | 1.15 | 15.55 | 12.80 | 82.31 | 0.760 |
| December | 1.12 | 17.50 | 15.80 | 90.28 | 0.630 |
| January | 1.37 | 18.80 | 16.68 | 88.72 | 0.380 |
| February | 1.28 | 19.80 | 17.60 | 89.79 | 0.280 |
| March | ------ | 20.47 | 18.15 | 88.66 | ------ |
| April | 1.60 | 18.45 | 16.10 | 87.26 | 0.310 |

LUZON NO. 2.

| | | | | | |
|---|---|---|---|---|---|
| October | 1.50 | 16.10 | 13.70 | 85.09 | 0.720 |
| November | 1.22 | 17.02 | 14.70 | 86.36 | 0.530 |
| December | 1.20 | 17.35 | 15.50 | 89.33 | 0.308 |
| January | 1.20 | 17.68 | 14.60 | 82.57 | 0.280 |
| February | 1.35 | 18.65 | 16.30 | 87.39 | 0.250 |
| March | ------ | 18.97 | 17.00 | 89.61 | ------ |
| April | 1.35 | 18.92 | 16.72 | 88.37 | 0.390 |

LUZON NO. 3.

| | | | | | |
|---|---|---|---|---|---|
| October | 1.21 | 16.50 | 13.90 | 84.24 | 0.640 |
| November | 1.02 | 18.55 | 16.40 | 88.40 | 0.400 |
| December | 0.90 | 17.70 | 15.90 | 89.83 | 0.520 |
| January | 1.16 | 17.08 | 14.70 | 86.06 | 0.590 |
| February | 1.23 | 18.20 | 15.70 | 86.26 | 0.600 |
| March | ------ | 18.50 | 16.33 | 88.27 | ------ |
| April | 1.53 | 19.92 | 17.30 | 86.84 | 0.320 |

*Average analyses of cane juices from varieties growing at the La Carlota Experiment Station, Occidental Negros, 1914–1915*—Continued.

LUZON NO. 4.

| Month. | Weight of stalk. | Brix. | Sucrose. | Purity. | Glucose. |
|---|---|---|---|---|---|
| | *Kilos.* | | | | |
| October | 1.49 | 16.90 | 14.30 | 84.61 | 0.640 |
| November | 1.45 | 16.40 | 14.10 | 85.97 | 0.400 |
| December | 1.20 | 16.20 | 14.10 | 87.03 | 0.520 |
| January | 1.50 | 15.70 | 13.38 | 85.22 | 0.590 |
| February | 1.35 | 17.65 | 15.07 | 85.38 | 0.600 |
| March | | 18.53 | 15.76 | 85.05 | |
| April | 1.50 | 17.92 | 14.85 | 82.86 | 0.240 |

FORMOSA.

| Month. | Weight of stalk. | Brix. | Sucrose. | Purity. | Glucose. |
|---|---|---|---|---|---|
| October | 1.42 | 16.58 | 13.20 | 79.61 | 0.860 |
| November | 1.56 | 18.70 | 16.00 | 85.56 | 0.647 |
| December | 1.90 | 17.20 | 14.80 | 86.04 | 0.480 |
| January | 1.42 | 16.90 | 14.58 | 86.27 | 0.500 |
| February | 1.54 | 18.45 | 16.50 | 89.43 | 0.380 |
| March | 1.50 | 19.75 | 17.90 | 90.63 | 0.570 |
| April | 1.51 | 18.82 | 16.47 | 87.51 | 0.260 |

CHINOISE 3526.

| Month. | Weight of stalk. | Brix. | Sucrose. | Purity. | Glucose. |
|---|---|---|---|---|---|
| October | 1.26 | 16.70 | 14.20 | 85.02 | 0.570 |
| November | 1.10 | 16.90 | 14.50 | 85.79 | 0.557 |
| December | 1.54 | 15.88 | 12.90 | 81.23 | 0.880 |
| January | 1.30 | 19.40 | 17.00 | 87.62 | 0.190 |
| February | 1.26 | 19.60 | 14.74 | 75.20 | 0.210 |
| March | | | | | |
| April | 1.05 | 21.15 | 18.70 | 88.41 | 0.240 |

LOUISIANA PURPLE.

| Month. | Weight of stalk. | Brix. | Sucrose. | Purity. | Glucose. |
|---|---|---|---|---|---|
| October | 1.54 | 15.88 | 12.90 | 81.23 | 0.886 |
| November | 1.10 | 16.90 | 14.50 | 85.79 | 0.557 |
| December | 1.26 | 16.70 | 14.20 | 85.02 | 0.570 |
| January | 1.20 | 16.20 | 12.40 | 76.54 | 0.487 |
| February | | | | | |

The above represent an average of composite samples taken each week during the respective month.

At the close of work at Isabela on June 1, the laboratory apparatus was returned to La Carlota and put in shape for the work on the different varieties at that station, and cane from the plantations of that vicinity. This work was again resumed on November 1, and cane will be transferred to the laboratory from the various sugar districts during the present year so that reports on cane from the different districts in addition to that growing in the vicinity of the station will be available this year.

### ALABANG EXPERIMENT STATION.

Three hectares of sugar cane and forage cane were grown at this station for the purpose of furnishing points for distribution. The following varieties were grown at Alabang: Hawaii 16, 20, 27, 69, 227, 309, Lahaina, Yellow Caledonia, Rose Bamboo, Louisiana Striped, D 1135 and Uba Forage Cane. There were also a few rows of different varieties which may possibly prove of value, but these varieties have only been grown in limited quantities for purposes of observation.

The distribution of cane points was started during September in order that the lower joints while yet unmatured might be used for planting. More than eighty thousand points of improved varieties of sugar cane have been distributed from this station since the first of the year.

In addition to the above, an equal amount of the Uba forage cane was forwarded to planters.

### SINGALONG EXPERIMENT STATION.

Work of propagating seedling varieties was carried on at this station and the seedling cane was planted on the plot between Indiana and Wright streets. This plot has now growing upon it one row or in some cases only a portion of a row of each variety now in the possession of this Bureau.

### DEMONSTRATION AND EXTENSION WORK.

During the past year land was set aside for demonstration stations at one or more places in each of the following provinces: Pampanga, Pangasinan, Tarlac, Bulacan, Nueva Ecija, Rizal, Laguna, Batangas, Cebu, Iloilo, and Mindoro. Each of our coöperators was furnished cane points and supervision of the work by the Bureau. The purpose of this project is to demonstrate the superiority of the improved varieties of cane over the native cane, instruct the planter in better cultural methods and give them a start in the improved varieties of cane.

Each of these plots was visited from time to time by the sugar technologist and during the milling season the factories were likewise visited and suggestions offered with a view of improving the grade of the finished product.

The following publications on the subject of sugar were distributed to the planters during the past year:

| | |
|---|---|
| Circular No. 31. Cane Varieties | 1493 |
| Circular No. 32. Cultivation of Cane | 1967 |
| Circular No. 33. Making of Muscovado Sugar | 896 |

It has long been recognized that the methods employed in milling the cane and clarifying the juice here have been the cause of low yields and the poor quality of the finished sugar. In order to remedy this condition 19 apparatuses were constructed embodying the principles of modern systems of settling and filtering cane juices, and personal instructions were given to the managers in various mills by the sugar technologist in the use of these apparatuses. Instruction was also given in the proper setting of the mills, the handling of the juice, and the crystallization of the sugar. Plots of land were set aside by many of the planters for the purpose of planting improved varieties of cane as well as the native varieties. These plots are started for two reasons, namely, to prove the superiority of the improved varieties over the native cane, and to give the planters a start with the improved varieties.

This cane will be cut and points planted in order to increase the area as rapidly as possible. By the above system the planters will be able to increase this area more than twenty times the original planting in the course of a year.

### GRASSES, LEGUMES, AND COVER CROPS.

This project embraces seed production and all experimental work with grasses, legumes and forage crops.

During the year plots varying from one-fifth to several hectares in area were cropped with Lyon, patani, and Canadian Wonder beans, cowpeas, several varieties of peanuts, sweet potatoes, Guinea, Para, paspalum, and Sudan grass.

In growing Lyon beans the experiments indicate that the best results with reference to both seed production and to the formation of a good cover crop, are secured when the sowings are made during the later part of the rainy season. Sowings made at this time enable the plants to thoroughly establish themselves before the dry season sets in and allows them to mature their seed at a favorable time.

A small plot of native patani beans was grown and made an excellent showing as a cover crop. This bean bids fair to excel the Lyon bean as a cover crop.

The Canadian Wonder beans were grown only for the purpose of producing seed. This variety has met with favor and has been adopted by the people living on the La Carlota station as a desirable addition to their food.

The cowpea has proved its worth, both as a cover crop and as a food for human consumption, and a considerable area of this legume was planted with the view of producing a large amount of seed for distribution purposes. Unfortunately, how-

ever, due to the attacks of aphids and to excessive wet weather which caused the pods to mold and rot as fast as they matured, the production of good seed was practically nil.

Poor success attended the growing of peanuts, due mainly to the wet weather which prevented adequate cultivation. It appears that peanuts cannot be successfully grown during the rainy season.

Three plots of sweet potatoes representing the American Large White, Large New Jersey Red and Momungan varieties were planted during the later part of October. All the varieties have made a good growth and will furnish abundant propagating material for distribution.

A small field of native sweet potatoes planted during September made an exceptional growth and were utilized as hog feed.

Among the various grasses grown the Guinea grass is, all things considered, probably the best all-around forage grass. Due to an unusually wet season the Guinea grass made a very good growth practically every month with no irrigation whatever. Where there is sufficient moisture throughout the year to keep the plants in a good growing condition Guinea grass excels all other grasses as a forage plant. A considerable quantity of roots were distributed to farmers in the vicinity of La Carlota.

Sudan grass equals the Guinea grass in yield and has the added advantage of requiring less moisture for its growth. However, an objectionable feature to Sudan grass is that if allowed to seed the plants die out and the forage harvested at that time is of little value, being coarse and woody. Guinea grass is palatable to stock when cut during any stage of its growth.

The Para grass plot which made a satisfactory growth during the year was not pastured but was cut from time to time for horse feed. This grass is especially adapted to low-lying or moist land and produces an abundance of forage on this type of soil.

## LA CARLOTA EXPERIMENT STATION.

The work of the Plant Industry Division at the La Carlota Station is carried on under the rice, corn, sugar cane and grass and forage projects, and is reported on under these projects.

## SINGALONG EXPERIMENT STATION.

The plant industry work carried on at the Singalong Station may be grouped under the following heads: Bananas, nursery, sugar cane, forage and cover crops, ear-to-the-row test with Lobo yellow corn, root crops, and plant propagation and distribution.

These phases of the work will be taken up successively and the work accomplished under each project during the year briefly summarized.

*Bananas.*—In order to supply suckers for free distribution plants of five varieties of bananas, namely, Buñgulan, Lacatan, Latundan, Sabá, and Ternate, were reserved from the large banana collection transferred to Los Baños last year, and planted on the station. These plants have made an excellent growth during the past year and a number of suckers are now ready for distribution.

*Nursery.*—The nursery work was confined largely to the transplanting and care of considerable numbers of economic and ornamental plants such as chicos, mangos, tamarinds, bauhinias, mabolos, rain trees, palms, etc.

Some budding work was also carried on, principally with the annonas.

Different strengths of formalin and formalin-bordeaux sprays ranging in the amount of formalin from 2 to 20 parts were tested out on citrus plants infected with canker disease with the result that any amount over 4 parts of formalin proved injurious to the plants and in some instances entirely killed them. The weaker formalin sprays, however, proved their worth in at least keeping the canker disease in check and in some instances apparently eradicated the disease.

## FORAGE AND COVER CROPS.

*Guinea grass.*—The area devoted to the culture of Guinea grass has been relatively large, for two reasons, that a constant supply of green forage might be provided for the animals at the station, and that roots might be available for distribution. Due to a lack of rain during the forepart of the year the Guinea grass was in rather poor condition, but with the application of irrigation water during the dry months the grass showed marked improvement. Two plots of ten rows each of the grass were given applications of fertilizers, one copra meal and the other dried blood at the rate of 400 pounds per hectare in order to compare the results produced by the two sources of nitrogen.

Aside from the usual periodical irrigation, cultivation, harvesting, and preparing roots for distribution, there has been nothing further done with the Guinea grass plots during the year.

*Soy beans.*—Several varieties of these beans were planted during the forepart of the year but germinated poorly. Due mainly to a lack of bacterial root nodules the plants, with the exception of one variety, No. 199, made a poor growth and the results obtained were inconclusive. Variety No. 199, however, produced root nodules in considerable numbers and its thrifty appearance as compared with the other varieties was striking.

*Cowpea* (*New Era*).—Aside from the planting of cowpeas between the rows of a portion of the Guinea grass with the object in view of observing the effect, if any, a leguminous crop would have upon the growth and vigor of the grass; and a similar planting between the banana rows, cowpeas were planted on land not otherwise occupied, principally as a green manure crop. A small quantity of seed was harvested during the year. When grown as a green manure crop better results were obtained by broadcasting the cowpeas than by planting in drills.

*Ear-to-row test* (*Lobo yellow corn*).—This test was started during the month of February using selected Lobo yellow corn procured from the town of Lobo in Batangas.

This experiment consisted of 30 rows, each planted with a selected ear of as near the same type of corn as possible, and in addition two guard rows on each side of the plot and a check row every tenth row, making in all a plot consisting of 36 rows.

In order that cross fertilization might be assured one-half of each row, alternating halves, was detasselled, care be taken that the detasselling was done before the pollen ripened. The guard rows on each side of the plot were also detasselled.

The corn made excellent growth and was remarkably free from insect pests and stalk borers.

Several characteristics of this corn have been noted. Some stalks have as many as five ears, but in no case did all the ears fully developed. A most striking feature was the manner in which the husks on some ears functioned as leaves as well as a protective covering for the ear. The husk was close and tight over the ear but at a well-defined place grew away from the ear and took on the appearance and function of a leaf.

The corn was harvested during the month of April and selection made for further plantings.

*Root crops.*—Seven varieties of gabi were harvested during

the first month of the year and a limited number of tubers distributed.

The sweet-potato tests have been continued during the year according to the scheme in vogue last year.

Three varieties of sweet potatoes were grown, namely American Large White, New Jersey Red, and Momungan. These varieties were all planted in ridged and flat rows 1 meter apart but at varying distances in the row ranging from 30 to 60 centimeters between each plant. With the larger varieties in ridged culture the highest production was obtained where the plants were spaced 50 centimeters apart in the rows.

A fertilizer test including sodium nitrate, potassium sulphate and acid phosphate applied separately and in combination at the rate of 400, 600, and 800 kilos per hectare was completed on the sweet potato plots during the year. The results which showed a greater yield of tubers from the unfertilized plots indicate that the nitrogenous fertilizers promoted the growth of vines to the detriment of tuber production.

Calculated on the basis of a hectare the New Jersey Red variety was the highest yielder, with 23,437 kilos of tubers on the unfertilized plot and 20,000 kilos where fertilizer was applied.

A large number of cuttings from the different varieties were distributed during the year.

*Plant propagation and distribution.*—The plant propagation work throughout the year has been very successful and large numbers of economic and a few ornamental plants have been distributed.

Among those plants propagated and distributed in the largest numbers were the following:

| | | |
|---|---|---|
| Papaya | plants | 571 |
| Coffee | do | 14,033 |
| Mango | do | 4,943 |
| Cacao | do | 21,973 |
| Sweet potato | cuttings | 54,410 |
| Guinea grass | stools | 12,400 |

A total of 135,916 plants and cuttings, economic and ornamental, were distributed from the Singalong station during the first 10 months of the year.

LAMAO EXPERIMENT STATION.

The work at the Lamao station is carried on under the following projects: Tropical fruits, citrus fruits, avocados, mangos, pineapples, papayas, coffee, nursery and plant distribution, root

PHILIPPINE FRUIT TREES.

(*a*) *Artocarpus odoratissima*, $2\frac{1}{2}$ years from seed, 1 year from planting in the field. Lamao Experimental Station.

(*b*) Seedless mabolo, *Diospyros discolor*, shield budded. Lamao Experiment Station.

crops, vegetables, seed growing, live stock, extension and maintenance.

These phases of the work will be taken up successively and the work accomplished under each project during the year briefly summarized.

*Tropical fruits.*—The tropical fruit collection at Lamao now includes the following species: Akee, *Blighia sapida;* Alacao, *Palaquium phillipense;* Alaga, *Uvaria sorsogonensis;* Alpay, *Euphoria cinerea;* Anigli, *Annona senegalensis,* Antol, *Garcinia vidallii;* Aracá, *Psidium guineense;* Argena, *Eugenia edulis;* Atemoya, *Annona* sp.; Avocado, *Persea americana;* Bachang, *Mangifera foetida;* Bael, *Aegle marmelos;* Bageja, *Canarium moluccana;* Balubat, *Eugenia* sp.; Banágo, *Gnetum gnemon;* Banauac, *Uvaria rufa;* Bangar, *Sterculia foetida;* Baniti, *Garcinia dulcis;* Barobo, *Diplodiscus paniculatus;* Bauno, *Mangifera verticillata;* Berba, *Rheedia edulis;* Bignay, *Antidesma bunius;* Binjai, *Mangifera caesia;* Binucao, *Garcinia binucao;* Biriba, *Rollinia orthopetala;* Bobonáo, *Aglaia everettii;* Brazil nut, *Bertholletia nobilis;* Breadfruit, *Artocarpus communis;* Britoa, *Britoa acida;* Bulála, *Nephelium mutabile;* Burung, *Baccaurea dulcis;* Caimitillo, *Chrysophyllum oliviforme;* Calapi, *Calamus ornatus* var. *philippinensis;* Camia, *Averrhoa bilimbi;* Carambola, *Averrhoa carambola;* Caraunda, *Carissa carandus;* Cashew, *Anacardium occidentale;* Casimiroa, *Casimiroa edulis;* Catmon, *Dillenia philippinensis;* Cattley, *Psidium cattleianum;* Caymito, *Chrysophyllum cainito;* Cefalus, *Sarcocephalus esculentus;* Ceriman, *Monstera deliciosa;* Cherimoya, *Annona cherimolia;* Chico, *Achras sapota;* Chico-Mamey, *Lucuma mamosa;* Connácon, *Eleocarpus calomala;* Corica, *Coccoloba* sp.; Cos, *Psidium friedrichsthalianum;* Cubili, *Cubilia blancoi;* Custardapple, *Annona reticulata;* Dalinsi, *Terminalia edulis;* Date, *Phoenix dactylifera;* Derma, *Annona scleroderma;* Duhat; *Eugenia jambolana;* Duku, *Lansium domesticum* var. *duku;* Durian, *Durio zibethinus;* Feijoa, *Feijoa sellowiana;* Galó *Anacolosa luzoniensis;* Genipa, *Genipa americana;* Gomihan, *Artocarpus elastica;* Grumichama, *Eugenia braziliensis;* Guanábano, *Annona muricata;* Guava, *Psidium guajava;* Guisaro, *Psidium molle;* Hevi, *Spondias cytheræ;* Hondapara, *Dillenia indica;* Iba, *Cicca disticha;* Icaco, *Chrysobalanus icaco;* Jak, *Artocarpus integra;* Juani, *Mangifera odorata;* Jujube, *Zizyphus jujuba;* Kabiki, *Mimusops elengi;* Kaiapple, *Aberia caffra;* Kanari, *Canarium commune;* Katuri, *Garcinia venulosa;* Kayam, *Inocarpus edulis;* Kechapi, *Sandoricum radiatum;* Ketembilla, *Aberia gardnerii;*

Kledang, *Artocarpus lancæfolia;* Kuching, *Nephelium malaiense;* Kundangan, *Bouea macrophylla;* Lamuta, *Cynometra cauliflora;* Lanno, *Spondias pinnata;* Lanzon, *Lansium domesticum;* Lauriva, *Psidium laurifolium;* Lemasa, *Artocarpus polyphoema;* Lipóti, *Eugenia curranii;* Litchi, *Litchi chinensis;* Longan, *Euphoria longana;* Mabólo, *Diospyrus discolor;* Macopa, *Eugenia javanica;* Malpi, *Malpighia glabra;* Mamón *Annona glabra;* Mandalika, *Artocarpus rigida;* Mastic, *Sideroxylon mastichodenron;* Mirim, *Rollinia emarginata;* Mitnai, *Artocarpus* sp.; Mombin, *Spondias lutea;* Mango, *Mangifera indica;* Mangosteen, *Garcinia mangostana;* Marang, *Artocarpus odoratissima;* Marón, *Annona montana;* Mulberry, *Morus alba;* Nelli, *Phyllanthus emblica; Nephelium eriopetolum;* Paho, *Mangifera altissima;* Palali, *Dillenia riefferscheidia;* Pangao, *Sterculia oblongata;* Pangi, *Pangium edule;* Paniala, *Flacourtia cataphracta;* Papaya, *Carica papaya;* Parcha, *Passiflora laurifolia;* Pereskia, *Pereskia aculeata;* Phalsa, *Grewia asiatica;* Pili, *Canarium ovatum;* Pineapple, *Ananas sativus;* Pinho, *Rollinia* sp.; Pitanga, *Eugenia uniflora;* Pomegranate, *Punica granatum;* Rambi, *Baccaurea motleyana;* Rambutan, *Nephelium lappaceum;* Rukam, *Flacourtia rukam;* Salak, *Zalacca edulis;* Santol, *Sandoricum koetjape;* Seagrape, *Coccoloba uvifera;* Serali, *Flacourtia ramontchi;* Soncoya, *Annona purpurea;* Sugarapple, *Annona squamosa;* Tamarind, *Tamarindus indica;* Tersana, *Eugenia malaccensis;* Tiessa, *Lucuma rivicoa* var. *angustifolia;* Vilatti, *Feronia elephantum;* Voavanga, *Vangueria madagascariensis;* Wampi, *Clausena wampi;* Yambo, *Eugenia jambos;* Yaruma, *Cecropia palmata;* Zapote, *Diospyrus ebenaster.* An unidentified species of Carissa fruited for the first time. The Giant cherimoya proved to be of exceptional merit, the Ketembilla is of unusual value for preserves, and the Cattley, Hevi, and Carissa are of very good quality for eating out of hand. The Bael trees continued to bear regular crops and provided ample material for the propagation of this fruit which will unquestionably be a favorite with the Filipinos, judging from experience at Lamao. The Marons fruited so far are of rather poor quality. The Paniala has not proved productive, and would perhaps do better at a higher altitude. The Biriba is a good addition to Philippine fruits. The Iba proved a poor bearer and the trees will be dug out to be replaced with other trees grown from seed of a superior variety introduced from Florida. The Guisaro is of good flavor, but rather small. The Pereskia gives promise to bear abundant and good fruits. The Pitanga is

also of good quality. The phalsa is well flavored but small fruited. The fruit of the Caymito was unfortunately lost.

The testing and selection of the Banauac was continued. The fruit of this plant increased nearly 100 per cent in size in cultivation on some plants. Quite a number of the Hevi trees fruited and all the plants, 97, were numbered and a beginning made in selection work.

Several Atemoya plants died, evidently from premature old age; others showed a tendency to be more prolific, though the fruit continued somewhat undersized. The Cuatemoya (hybrid between the Custardapple and the Atemoya) bloomed but did not fruit; they have a remarkable range of variability and are very vigorous. One hundred and sixty-four Annona hybrids were set out for testing in the field.

The Muscadine grapes made fair progress.

The experimental work in vegetative propagation was continued and detail requirements worked out in the following species: Alpay, Bulala, Wampi, Guisaro, Icaco, Lipoti, Litchi, Rambutan, Pangi, Akee, Cubili, Longan, Anigli, Alacao, and Mombin. It was also demonstrated that the Anigli may be budded on the Guanábano, Custardapple, Sugarapple and Mamon, and the Soncoya on the Custardapple and Guanábano.

*Citrus fruits.*—With few exceptions the citrus tress continued to make good progress. The budded collection planted in fields A, B, and C contains the following-named varieties of oranges: Valencia, Pineapple, Washington Navel, Jaffa, Ruby, Holdfast, Mediterranean, Larrantta, White Siletta, Bahia, St. Michaels, Sawyer's Navel, Excelsior, Navelencia, Majorca, Malta Blood, Homosassa, Brown, Enterprise, Tardiff, Vinous, Duroi, Dugat, Whitaker, Magnum Bonum Carleton, Nonpareil, Seville, St. Jago, Boone, Paperind, Foster, Jappa; the following varieties of mandarins: Molana, Ladu, Oneco, Mandarin, King, Konda Narun, Kishiu, Medilla, Saltsumamikan, Dancy, China, Malvar, Rafael, Szinkom, Suntara, Nagpur, Unshiu, Uday, Batangas; the following varieties of pomelos: Ellen, Pernambuco, Marsh, Triumph, McCarthy, Siam, Walters, Royal, Duncan, Kellogg, Gaerlan, Panuban; and the following varieties of limes; Tahiti, Trinidad, Engal, Everglade, the Sampson tangelo and the Nagami kumquat.

There are also 112 sorts of native budded citrus tress under observation including the following species: *Citrus aurantium, C. vulgaris, C. medica, C. nobilis, C. nobilis* var. *papillaris, C. excelsa, C. histrix, C. webberii, C. limonum, C. decumana,*

*C. limetta, C. longispina, C. webberii* var. *montana, C. macrophylla, C. southwickii, C. histrix* var. *boholensis, C. histrix* var. *torosa, C. micrantha, C. micrantha* var. *microcarpa, C. pseudolimonum, C. limetta* var. *aromatica.*

The collection of native and miscellaneous citrus trees not budded consists of 452 trees of 86 serial numbers. These are planted in fields N and O. No trees have been planted in the field this year.

The Duroi, No. 4120, and Dugat, No. 4119, oranges have fruited, also the Satsumamikan, No. 1273, and No. 3389, one of the Siamese pomelos. No. 744, *citrus sp.*, Molana; the lemons, No. 1702, Villa Franca, No. 591, Belair, No. 1634, Valencia and No. 1642, Clarke; the limes, Nos. 902 and 958, and two Calamondins, Nos. 2513 and 2534, have also fruited. All the above-mentioned varieties have been found of superior merit along their respective lines and warrant propagation for distribution, the Satsumamikan perhaps excepted, which is too acid to be likely to meet with favor. The Siam, Duroi, Dugat, and the Molana deserve especial mention for their excellence. It is perhaps worthy of record that the pomelo was seedless. Aside from the ones mentioned above various native citrus trees have also fruited but are not found to be of any commercial value. Except specimen plants that will be retained for botanical study all these will be destroyed at an early date.

Two lots of budwood of citrus hybrids were received from Mr. W. T. Swingle, Bureau of Plant Industry, United States Department of Agriculture. The first lot contained 96 kinds of which 62 varieties were successfully budded, most of which are growing. The second lot contained 194 hybrids, but it is yet too early to report on the success of the work. Ninety-nine budded citrus hybrid trees were also received from Mr. Swingle, all of which arrived in good order. Ten native citrus fruits were collected by the horticulturist in charge during his trip through the Mountain Province and Nueva Vizcaya. All the above-mentioned material is still in the nursery.

Experiments in spraying for citrus canker have been conducted with the following formulas made by Mr. E. D. Doryland, agricultural inspector:

*Creolin spray* (creolin and water):

(1) 1 : 49; (2) 1 : 69; (3) 1 : 89 (4) 1 : 109.

*Formalin-Creolin spray* (formaldehyde and Creolin emulsion):

(1) 1 : 99.

*Formalin spray* (formaldehyde and water):

(1) 1 : 79; (2) 1 : 99; (3) 1 : 119.

Formalin-Bordeaux (formaldehyde and bordeaux mixture):

(1) 1 : 99.

After the preliminary tests during the early part of the year, all the sprays were discontinued in favor of the Formalin-Bordeaux spray (1 : 99).

The sprayings demonstrated that by continued frequent applications the citrus canker can be controlled, but the feasibility of controlling or eradicating the canker by the means of a spray in field practice has not as yet been fully demonstrated.

*Avocados.*—The old seedlings fruited as usual, and are fairly prolific, but only one has shown sufficient merit to warrant propagation beside the Lyon, named and described in the PHILIPPINE AGRICULTURAL REVIEW. A number of the poorest trees were destroyed. A few of the weakest trees in the budded avocado orchard died, but most of the remainder are making excellent progress, and some may come into fruiting next year.

The orchard contains 60 trees including the following varieties: Cummins, Miami, Dickinson, King, Largo, Douglas, Lyon, Marco, Wester, Pollock, Family, Cardinal, Quality, Baldwin, Tardena, Vega, Commodore, Cyrus, Imperial, and the unnamed varieties Nos. 3680, 3682, 3756, 3774, 3775, 4095, 4843, 4846, 4847, 4864 and 4867.

*Mangos.*—The East Indian mangos made slow but steady progress. The collection includes the following varieties: Naspati, Gopalbhog, Tamancha, Sandurea, Krishna Bhog, Chickna, Bombay Green, Bombay Yellow, Alfonso, Malda, Kachamitha, Davy's Favorite, Langra, Kutna, Salibunda, Sufaida, Kakaria, Surkha, Najibabadi Amin, Cambodiana, Sharbati Black, Stalkart, Singia, Biscoa Mukha, Skrihas, Gelee and Gading.

It is planned to set out these mangos in a separate field during the coming year.

*Pineapples.*—Cogon grass (*Imperata cylindrica*) had gradually invaded the old pineapple field until it became impracticable to longer maintain it, and the plants were therefore uprooted and a part transplanted to field N to complete the planting of last year. The pineapples planted at Lamao at the close of the fiscal year include 2771 Cayenne, 1812 Queen, 1347 Spanish, 95 Sugar-loaf, 25 abaka, 227 Hybrids.

Several plants of the Sugar loaf fruited for the first time, but owing to the fact that the fruit was stolen from the field there was no opportunity to test it. Of the hybrids a Deliciosa fruited and was found to be of excellent quality. The Cayenne, Spanish, and Queen bore a fair crop.

*Papayas.*—The work on this project has been confined to the planting of 81 young plants in the citrus orchard for seed production, and the saving of seed for distribution.

*Coffee.*—While no coffee project was organized until in the third quarter of the year, much time was devoted to the propagation of coffee during the earlier part of the year. Experiments have also been conducted in budding and grafting coffee, which terminated satisfactorily by the end of the season. For a detailed account of this work see article by P. J. Wester on this subject in the PHILIPPINE AGRICULTURAL REVIEW.

A block of 150 Excelsa and 70 Liberian coffee shaded by Ipil-ipil (*Leucaena glauca*), was set out on field E with the object of demonstrating modern methods of growing coffee and to provide seed for future distribution. These plants are making good progress.

Five hundred and twelve flats of seeds were sown during the year as follows:

| | Flats. |
|---|---|
| Bael | 9.5 |
| Biriba | 8.0 |
| Baago | 16.5 |
| Coffees | 157.0 |
| Citrus | 33.0 |
| Carambola | 4.0 |
| Date | 14.0 |
| Custardapple | 8.0 |
| Guanabano | 6.0 |
| Lanzon | 6.0 |
| Libato | 15.0 |
| Mangosteen | 10.0 |
| Kayam | 10.0 |
| Genipa | 8.0 |
| Ipil-ipil | 21.0 |
| Phalsa | 4.0 |
| Pili | 42.0 |
| Rukam | 1.0 |
| Sugarapple | 11.5 |
| Royal palm (*Oreodoxa regia*) | 32.5 |
| Yaruma | 12.0 |
| Talinum | 4.0 |
| Ketembilla | 4.5 |
| Miscellaneous plants | 63.5 |

The various activities of a nursery such as transplanting, budding, and packing of plants and all work incidental thereto was continued as usual. As a result there are now in the nursery, the plant shed, and in bamboo tubes the following plants:

| | Plants. |
|---|---|
| Coffee: | |
| Various types of Robusta | 10,733 |
| Liberian | 3,027 |
| Excelsa | 9,579 |
| Canephora | 895 |
| Abeocuta | 1,644 |
| Congo | 467 |
| Uganda | 1,283 |
| Quillou | 405 |
| Shade trees for coffee: | |
| Deguelia | 50 |
| Albizzia | 35 |
| Adenanthera | 116 |
| Ipil-ipil | 488 |
| Tropical fruits: | |
| Annonaceous plants: | |
| Seedlings | 5,775 |
| Budded | 2,562 |
| Avocado plants: | |
| Seedlings | 749 |
| Budded | 57 |
| Bael | 921 |
| Bignay | 82 |
| Carissa | 69 |
| Calape | 7 |
| Carambola | 1,710 |
| Citrus plants: | |
| Seedlings | 18,145 |
| Budded | 4,380 |
| Date | 482 |
| Duhat | 274 |
| Grapes (*Vitis* sp.) | 149 |
| Kayam | 319 |
| Kanari | 71 |
| Ketembilla | 48 |
| Marang | 576 |
| Mangosteen | 535 |
| Mango: | |
| Inarched | 41 |
| Seedlings | 151 |
| Budded | 17 |
| Mabolo | 39 |
| Pili | 156 |
| Alaga | 122 |
| Yaruma | 630 |
| Miscellaneous species | 714 |

| | Plants. |
|---|---|
| Ornamentals: | |
| Royal palm | 2,148 |
| Caryota sp. | 20 |
| *Latania rubra* | 2 |
| Bohol palm (*Unidentified* sp.) | 180 |
| *Orania regalis* | 18 |
| *Areca rubra* | 1 |
| Bignonia | 88 |
| Raintree (*Pithecolobium, saman*) | 30 |
| Panama-hat palm (*Carludovica palmata*) | 5 |

There are at present 121 flats of coffee in the germination stage that promise a great abundance of plants, and 179 flats of other species.

The following plant distribution was made during the year:

| | | |
|---|---|---|
| Annonaceous plants, seedlings | plants | 406 |
| Annonaceous plants, budded | do | 351 |
| Annonaceous plants, scions | | 127 |
| Avocado, seedlings | plants | 447 |
| Avocado, budded | do | 138 |
| Avocado, scions | | 23 |
| Bael | plants | 542 |
| Carambola | do | 20 |
| Carissa | do | 121 |
| Carandas | do | 40 |
| Calape | do | 94 |
| Citrus, budded | do | 155 |
| Date | do | 515 |
| Durian | do | 48 |
| Grumichama | do | 70 |
| Gomihan | do | 270 |
| Grapes | do | 58 |
| Ketembilla | do | 42 |
| Kayam | do | 33 |
| Kanari | do | 55 |
| Lanzon | do | 57 |
| Lipoti | do | 252 |
| Marang | do | 414 |
| Mangos | do | 61 |
| Mombin | do | 45 |
| Mangosteen | do | 169 |
| Pereskia | do | 236 |
| Pili | do | 394 |
| Yaruma | do | 83 |
| Tropical Fruits, miscellaneous species | do | 373 |

| | | |
|---|---|---|
| Coffee: | | |
| Robusta from Lamao | plants | 3,158 |
| Robusta from Java | do | 802 |
| Liberian from Lamao | do | 280 |
| Quillou | do | 259 |
| Canephora | do | 372 |
| Congo | do | 259 |
| Uganda | do | 284 |
| Excelsa | do | 290 |
| Excelsa seed | in tube | ½ |
| Abeocuta seed | do | ½ |
| Shade trees for Coffee | plants | 108 |
| Pineapples: | | |
| Queen | do | 6,820 |
| Cayenne | do | 3,444 |
| Spanish | do | 709 |
| Hybrids | do | 224 |
| Sugarloaf | do | 165 |
| Maguey, suckers | do | 120,110 |
| Maguey, bulbils | do | 159,000 |
| Sisal | do | 23,100 |
| Carludovica | do | 27 |
| Ornamentals: | | |
| *Areca rubra* | do | 65 |
| Bohol palm (*Unidentified*) | do | 242 |
| Bignonia | do | 414 |
| *Caryota urens* | do | 50 |
| Pedilanthus | do | 67 |
| Royal palm | do | 22 |
| *Richardia thurstonii* | do | 103 |
| Washington palm (*Washingtonia robusta*) | do | 30 |
| Miscellaneous species | do | 134 |
| Orchids | boxes | 2 |
| Various cuttings | | 1,448 |

Since the beginning of the dry season in the latter part of the year the following number of stocks were successfully budded:

| | |
|---|---|
| Citrus | 1,511 |
| Annonaceous plants | 2,175 |
| Carambola | 85 |
| Seedless mabolo | 7 |

Experiments have been conducted in rooting bamboo which have been highly successful.

*Root crops.*—The work with root crops has been confined almost entirely to yams (*Dioscorea* Sp.), 0.2 hectare being planted in the spring which have just been harvested. These include 34 serial numbers, of which 33 constitute the selections made from the original collection of 85 kinds, and one is a reputedly very good variety obtained in Bayombong, Nueva

Vizcaya, by the horticulturist in charge. A new series of notes were taken at the time of harvesting and the final selection can undoubtedly be made before this season's crop is again planted.

Many of the varieties now on hand are excellent both in regard to yield and quality.

The camote (*Ipomoea* Sp.) from Java made good growth and proved prolific, but the potato was inferior in quality to that produced in Momungan. Possibly it might improve under other soil conditions.

The cassava (*Manihot utilissima*) from Java made excellent growth and the planting can be considerably extended during the coming year.

*Vegetables.*—As already stated on another page no work of importance has been done on this project except the breeding of the lima, which was done in connection with the following project.

*Seed growing.*—In value of the produce, this project is one of the most important of the station though the crops grown are cultivated mostly as auxillary or cover crops and thus have a double value. The areas occupied by the seed crops are as follows:

| | Hectares. |
|---|---|
| Cowpeas | 7.82 |
| Limas | 0.46 |
| Seguidillas (*Psophocarpus tetragonolobus*) | 0.21 |
| Cucumber | 0.29 |
| Corn | 0.35 |
| Native patani (*Phaseolus* sp.) | 0.64 |
| Libato (*Basella rubra*) | 0.12 |
| Lyon beans (*Mucuna lyonii*) | 0.08 |
| Yams | 0.19 |
| Roselle (*Hibiscus sabdariffa*), including Victor, Rico, and Archer | 0.49 |

A small plot was also planted to Talinum.

The cowpeas, cucumber, seguidillas and corn made a good growth and produced normally. The Lyon beans made a poor growth and failed to produce seed. The roselle made a good start, but in the latter part of the year diseases attacked the Victor and destroyed most of the plants; the Rico fared better, but the amount of seed produced was small; the Archer suffered scarcely at all and a good seed crop was harvested.

In connection with seed growing, breeding and selection work of the limas has been continued with gratifying results. In the present harvest 41 plants were selected and numbered and records kept of the yield. Sixteen of these bore over 800 pods per plant and 17 plants yielded not less than 500 grams of dried

beans per plant. Six plants bore pods and dried beans as follows: No. 5, 1,115 pods, 740 grams; No. 10, 1,044 pods, 692 grams; No. 21, 1,100 pods, 687 grams; No. 23, 1,408 pods, 965 grams; No. 32, 1,030 pods, 668 grams; No. 37, 1,070 pods, 736 grams.

A part of the seeds of the highest yielders was retained and sown for seed production, part sent to La Carlota for propagation.

Seed was sent to Manila for distribution as follows:

| | Kilos. |
|---|---|
| Cowpeas | 898.0 |
| White lima | [1] 496.5 |
| Lyon beans | 766.5 |
| Seguidillas | 118.0 |
| Guar (*Cyamopsis psoralioides*) | 14.0 |
| Cucumber | 27.3 |
| Roselle | 46.3 |
| Papayas | 5.8 |
| A mixed shipment of lima and seguidillas | 425.3 |

[1] And four sacks pods.

Two kilos and 39 packages of various seeds have also been sent to Manila for foreign seed exchange.

The 7.82 hectares planted to cowpeas, with the advent of the dry season, made excellent progress and gave an abundant crop.

### TOBACCO WORK.

During the first half of the year the work carried on under this project was conducted at the Anguapan station and consisted in testing experimentally certain native and foreign varieties of tobacco, and in propagating from the most suitable varieties, improved seed for distribution purposes in the Cagayan Valley. Work was also carried on dealing with the problem of producing a variety or type of tobacco which would make a desirable wrapper tobacco.

An experiment with corn and tobacco planted in alternate rows in such a manner that the corn would afford shade and protection for the tobacco, and thus assist in the production of a thin-leafed wrapper tobacco, was concluded during the forepart of the year. The results of this test were unsatisfactory as the corn rapidly outgrew the tobacco and afforded it little or no shade. For this reason it was necessary to construct a shade frame over the tobacco. From the 600 plants used in this experiment about 9,000 leaves were harvested during the months of April and May. The quality of the tobacco was excellent.

Aside from the 600 special plants grown under shade approximately 5,000 plants representing nine different varieties were grown at the station during the year.

During the month of September seeds of five different varieties of tobacco, Texas Cuban, Sumatra, Connecticut Havana, Vuelta Abajo, and Tirona Hybrid were planted in seed flats at Ilagan. These varieties gave good germination and were doing well until they were transplanted into seed beds at Dammao when owing to the constant heavy rains they were practically all destroyed. Seed flats of the same varieties were again made at Ilagan and kept under the propagation shed. A good germination was again obtained but before removing the plants for transplanting at Dammao they were attacked by fungus and only a few hundred plants, sufficient for experimental purposes, were saved.

Twenty experimental plots containing 40 square meters each have been prepared at Dammao and reserved for future plantings. Six of these plots have already been planted. Ten additional hectares are ready for planting, but owing to the continuous rains, field transplanting has been delayed.

## SEED AND PLANT DISTRIBUTION.

*Plants distributed from the Singalong Propagation Station from January 1 to December 15, 1916.*

| Name of plants. | Plants distributed. | Estimated value of plants distributed. |
|---|---|---|
| ECONOMIC PLANTS. | | |
| *Achras sapota*, "Chico" | 333 | $83.25 |
| *Aegle marmelos*, "Bael" | 18 | 4.50 |
| *Aleurites moluccana*, "Lumbang" | 114 | 28.50 |
| *Ananas sativa*, "Cayenne pineapple" (purchased) | 878 | 43.90 |
| *Annona atemoya*, "Atemoya" | 87 | 21.75 |
| *Annona muricata*, "Guanábano" | 171 | 42.75 |
| *Annona reticulata*, "Anonas" | 862 | 215.50 |
| *Annona squamosa*, "Ates" | 389 | 97.25 |
| *Antidesma bunius*, "Bignay" | 4 | 1.00 |
| *Arenga saccharifera*, "Kaong" | 60 | 15.00 |
| *Artocarpus integrifolia*, "Nangca" | 224 | 56.00 |
| *Carica papaya*, "Papaya" | 378 | 94.50 |
| *Citrus nobilis*, "Mandarin orange" | 354 | 88.50 |
| *Citrus decumana*, "Pomelo" | 113 | 28.25 |
| *Citrus limonum*, "Lemon" | 2 | .50 |
| *Citrus limetta* | 30 | 7.50 |
| *Citrus mitis*, "Calamondin" | 4 | 1.00 |
| *Citrus* sp | 4 | 1.00 |
| *Coccoloba* sp | 2 | .50 |
| *Coffea robusta*, "Robusta-coffee" | 16,345 | 4,086.25 |
| *Corypha elata*, "Buri" | 4 | 1.00 |
| *Colocasia* sp., "Gabi" | 350 | 2.00 |
| *Diospyros discolor*, "Mabolo" | 509 | 127.25 |
| *Elaeis guinensis*, "Oil palm" | 539 | 134.75 |
| *Euphoria lichi*, "Litchi" | 2 | .50 |
| *Euphoria longona* | 3 | .75 |
| *Ficus carica* | 4 | 1.00 |
| *Genipa americana*, "Genipap" | 18 | 4.50 |
| Halawihaw, *Unidentified* sp | 172 | 43.00 |
| *Hydnocarpus alcalæ* | 21 | 5.25 |
| *Lansium domesticum*, "Lansones" | 178 | 44.50 |

*Plants distributed from the Singalong Propagation Station from January 1 to December 15, 1916*—Continued.

| Name of plants. | Plants distributed. | Estimated value of plants distributed. |
|---|---|---|
| ECONOMIC PLANTS—continued. | | |
| *Mangifera indica*, "Carabao mango" | 7,508 | $877.00 |
| *Mangifera indica*, "Pico mango" | 964 | 241.00 |
| *Morus alba*, "White mulberry" (cuttings) | 213 | 1.06 |
| *Morus nigra*, "Black mulberry" (cuttings) | 150 | .75 |
| *Musa* sp., "Banana" in varieties | 1,195 | 71.70 |
| *Musa textilis*, "Abaca" (purchased) | 20 | 1.40 |
| *Nephelium litchi*, "Litchi" | 10 | 2.50 |
| *Passiflora laurifolia* | 2 | .10 |
| *Passiflora quadrangularis*, "Granadilla" | 157 | 7.85 |
| *Persea americana*, "Avocado" | 148 | 37.00 |
| *Psidium* sp., "Guava" | 557 | 27.85 |
| *Raphia ruffia* | 1 | .25 |
| *Sandoricum koetjape*, "Santol" | 36 | 9.00 |
| *Tamarindus indica*, "Tamarind" | 57 | 2.85 |
| *Theobroma cacao*, "Cacao" | 9,669 | 2,417.25 |
| *Vanilla* spp. (cuttings) | 28 | 1.40 |
| *Vitis* spp. (cuttings) | 43 | 2.65 |
| Total | 42,928 | 9,982.76 |
| CAMOTES AND FORAGE PLANTS. | | |
| *Ipomoea batatas* (cuttings in varieties) | 52,056 | 260.00 |
| *Panicum maximum*, "Guinea grass" | 1,628 | 81.40 |
| Total | 53,684 | 341.40 |
| ORNAMENTAL PLANTS AND SHADE TREES. | | |
| *Acalypha* sp | 2 | .05 |
| Amaryllis | 30 | .75 |
| Anahao (*Livistonia rotundifolia*) | 10 | 1.50 |
| *Allamanda hendersonii* | 3 | .07 |
| *Aristolochia ringens* | 1 | .15 |
| *Areca alba* | 2 | .30 |
| Bagawak (*Cloredendron minahassac*) | 12 | .30 |
| *Bauhinia* sp | 10 | .25 |
| Bird's-nest fern (*Asplenium nidus*) | 10 | 2.50 |
| Bonga de China (*Normanbya merrillii*) | 10 | 4.00 |
| Brazilian morning glory cuttings | 26 | 3.90 |
| Cannas in varieties | 7,472 | 37.36 |
| Caballero (*Caesalpinia pulcherrima*) | 109 | .54 |
| Cadena de Amor (*Antigonon leptopus*) | 14 | .07 |
| *Cassia siamea*, "Acacia" | 21 | 5.25 |
| *Castilloa elastica* | 91 | 4.55 |
| *Clitorea ternatea* | 123 | .61 |
| *Coleus* sp | 30 | .75 |
| Cucharitas (*Alternanthera versicolor*) | 50 | .25 |
| Dama de Noche (*Cestrum nocturnum*) | 6 | .30 |
| *Eucalyptus globulus* | 11 | 2.75 |
| *Euphorbia pulcherrima* | 2 | .10 |
| Gumamela (*Hibiscus* sp.) | 177 | 8.85 |
| *Ipomoea* sp | 53 | 1.82 |
| Ilang-ilang (*Cananga odorata*) | 15 | .75 |
| *Odontonema nitidum* | 64 | 3.20 |
| Oleander (*Nerium indicum*) | 16 | .40 |
| Orchids in varieties | 30 | 20.00 |
| Ornamental plants, miscellaneous | 84 | 4.20 |
| *Pothos aurea* | 2 | .05 |
| *Passiflora foetida* | 24 | 1.20 |
| *Peltophorum inerme* | 4 | .20 |
| Platito (*Nothopanax cochleatum*) | 13 | .06 |
| Rain tree (*Pithecolobium saman*) | 148 | 37.00 |
| San Francisco in varieties (*Codiaeum variegatum*) | 52 | 2.60 |
| *Sansevieria zeylanica* | 29 | 1.45 |
| Santan (*Ixora chinensis*) | 10 | .50 |
| Tiger tail | 20 | 1.00 |
| Traveler's palm (*Ravenala madagascariensis*) | 11 | 2.75 |
| Tuberose (clumps) (*Polianthus tuberosa*) | 31 | 1.55 |
| "Violetas" cuttings (*Barleria cristata*) | 3,167 | 15.83 |
| Wandering Jew (*Zebrina pendula*) | 150 | .75 |
| "Washington palm" (*Washingtonia robusta*) | 20 | 5.00 |
| Total | 12,171 | 174.96 |

*Plants distributed from the Singalong Propagation Station from January 1 to December 15, 1916*—Continued.

| Name of plants. | Plants distributed. | Estimated value of plants distributed. |
|---|---|---|
| SUMMARY. | | |
| Economic plants, fruit trees, and vines | 42,928 | $9,982.76 |
| Economic plants, camotes, and forage | 53,684 | 341.40 |
| Ornamental plants and shade trees | 12,171 | 174.96 |
| Grand total | 108,783 | 10,499.12 |

*Plants distributed from the Lamao Experiment Station from January 1 to December 15, 1916.*

| Name of plants. | Plants distributed. | Estimated value of plants distributed. |
|---|---|---|
| ECONOMIC PLANTS. | | |
| *Aberia gardnerii*, "Ketembilla" | 31 | $7.75 |
| *Aegle marmelos*, "Bael" | 392 | 98.00 |
| *Anacolosa luzoniensis*, "Galo" | 2 | .50 |
| *Ananas sativa*, "Cayenne pineapple" | 3,238 | 48.57 |
| *Ananas sativa*, "Hybrid pineapple" | 122 | 1.83 |
| *Ananas sativa*, "Queen pineapple" | 6,798 | 101.97 |
| *Ananas sativa*, "Spanish pineapple" | 693 | 10.39 |
| *Ananas sativa*, "Sugarloaf pineapple" | 165 | 2.44 |
| *Annona atemoya*, "Atemoya" | 163 | 40.75 |
| *Annona aterimoya*, "Aterimoya", budsticks | 35 | 1.75 |
| *Annona cherimolia*, "Cherimoya" | 84 | 21.00 |
| *Annona cuatemoya*, "Cuatemoya" | 8 | 2.00 |
| *Annona cuatemoya*, "Cuatemoya", budsticks | 6 | .30 |
| *Annona montana*, "Maron" | 221 | 55.25 |
| *Annona muricata*, "Soursop" | 2 | .50 |
| *Annona purpurea*, "Soncoya" | 47 | 11.75 |
| *Annona reticulata*, "Anonas" | 14 | 3.50 |
| *Annona squamosa*, "Sugarapple" | 22 | 5.50 |
| *Antedesma bunius*, "Bignay" | 24 | 5.50 |
| *Artocarpus elastica*, "Gomihan" | 245 | 62.75 |
| *Artocarpus ordoratissima*, "Marang" | 377 | 94.25 |
| *Artocarpus polyphoema*, "Lemasa" | 17 | 4.25 |
| *Artocarpus rigida*, "Mandalika" | 1 | .25 |
| *Averrhoa carambola*, "Balimbing" | 26 | 2.60 |
| *Averrhoa balimbi*, "Camias" | 6 | .60 |
| *Baccaurea dulcis*, "Burung" | 2 | .50 |
| *Bouea macrophylla*, "Kundangan" | 6 | 1.50 |
| *Bertholitia nobilis*, "Brazil nut" | 1 | .25 |
| *Calamus ornatus*, "Calapi" | 64 | 16.00 |
| *Calamus* sp | 14 | 3.50 |
| *Canarium commune*, "Canari" | 49 | 12.25 |
| *Canarium ovatum*, "Pili" | 386 | 96.50 |
| *Carissa arduina*, "Carissa" | 90 | 22.50 |
| *Carissa carandas*, "Caraunda" | 25 | 6.25 |
| *Carissa* sp | 4 | 1.00 |
| *Carissa* sp. "Round" | 16 | 4.00 |
| *Carludovica palmata*, "Panama hat palm" | 29 | 7.25 |
| *Cecropia palmata* | 26 | 6.50 |
| "Champedak" (cuttings) | 4 | 1.00 |
| *Cinammonum* sp | 2 | .50 |
| *Cica disticha*, "Iba" | 7 | 1.75 |
| *Citrus* sp. (budded) | 156 | 39.00 |
| *Coccoloba* sp | 15 | 3.75 |
| *Coffea canephora*, "Canephora coffee" | 372 | 93.00 |
| *Coffea congensis*, "Congo coffee" | 209 | 52.25 |
| *Coffea excelsa*, "Excelsa coffee" | 238 | 59.50 |
| *Coffea liberica*, "Liberian coffee" | 100 | 25.00 |
| *Coffea quillou*, "Quillou coffee" | 259 | 64.75 |
| *Coffea robusta*, "Robusta coffee" | 4,352 | 1,088.00 |
| *Coffea uganda*, "Uganda coffee" | 244 | 61.00 |
| *Cubilia blancoi*, "Cubili" | 4 | 1.00 |
| *Cola acuminata* | 1 | .25 |

*Plants distributed from the Lamao Experiment Station from January 1 to December 15, 1916*—Continued.

| Name of plants. | Plants distributed. | Estimated value of plants distributed. |
|---|---|---|
| ECONOMIC PLANTS—continued. | | |
| *Cynometra cauliflora*, "Lamuta" | 3 | $.75 |
| *Dillenia philipinensis*, "Catmon" | 11 | 2.75 |
| *Diplodiscus paniculatus*, "Barubo" | 12 | 3.00 |
| *Durio zibethinus*, "Durian" | 42 | 10.50 |
| *Elaeodendron orientale* | 31 | 7.75 |
| *Eugenia brasiliensis*, "Grumichama" | 67 | 16.75 |
| *Eugenia curanii*, "Lipoti" | 212 | 58.00 |
| *Eugenia jambolana*, "Duhat" | 8 | 2.00 |
| *Eugenia jambos*, "Yambo" | 66 | 16.50 |
| *Eugenia uniflora*, "Pitanga" | 2 | .50 |
| *Euphoria cinerea*, "Alpay" | 12 | 3.00 |
| *Euphoria longana*, "Longana" | 6 | 1.50 |
| *Feronia elephantum*, "Vilatti" | 2 | .50 |
| *Ficus religiosa* | 3 | .75 |
| *Flacourtia ramontchi*, "Serali" | 23 | 5.75 |
| *Flacourtia inermis*, "Louvi" | 2 | .50 |
| *Flacourtia rukam*, "Rukam" | 1 | .25 |
| *Flacourtia sapida* | 1 | .25 |
| *Garcinia dulcis*, "Baniti" | 15 | 3.75 |
| *Garcinia mangostana*, "Mangosteen" | 320 | 80.00 |
| *Genipa americana*, "Genipap" | 18 | 4.50 |
| *Grewia asiatica*, "Phalsa" | 6 | 1.50 |
| *Inocarpus edulis*, "Kayam" | 10 | 2.50 |
| *Ipomoea batatas*, "Camote" cuttings | 1,200 | 1.80 |
| Japanese sugar cane (forage), "Uba" | 320 | 4.80 |
| *Lansium domesticum*, "Lanson" | 36 | 9.00 |
| *Lichi chinensis*, "Lichi" | 4 | 1.00 |
| *Mangifera foetida*, "Bachang" | 4 | 1.00 |
| *Mangifera* sp., "Grafted mango" | 4 | 1.00 |
| *Mangifera* sp., "Indian mango" | 4 | 1.00 |
| *Mangifera* sp | 12 | 3.00 |
| *Mangifera* sp., "Inarched mango" | 21 | 5.25 |
| *Mangifera verticillata*, "Bauno" | 11 | 2.75 |
| *Manihot utilissima*, "Cassava" cuttings | 100 | .50 |
| *Moquilla platypus* | 2 | .50 |
| *Morus alba*, "White mulberry" (cuttings) | 500 | 2.50 |
| *Morus* sp., "Mulberry merritt" (cuttings) | 4 | .02 |
| *Musa* sp., "Banana" | 24 | 1.34 |
| *Nephelium lappaceum*, "Rambutan" | 5 | 1.25 |
| *Nephelium malaiense*, "Kuching" | 2 | .50 |
| *Persea americana*, "Avocado" | 442 | 110.50 |
| *Persea americana*, "Avocado" (budsticks) | 23 | 5.75 |
| *Passiflora quadrangularis*, "Granadilla" | 2 | .10 |
| *Phoenix dactilyfera*, "Date palm" | 425 | 106.25 |
| *Psidium cattleianum*, "Cattley Guava" | 5 | 1.25 |
| *Psidium friedrichsthalianum*, "Cos" | 6 | 1.50 |
| *Psidium laurifolium* | 8 | 2.00 |
| *Pedilanthus tithymaloides* | 1 | .25 |
| *Pereskia aculeata* "Pereskia" | 36 | 9.00 |
| *Rollinia orthopetala*, "Biriba" | 123 | 30.75 |
| *Rubus idaeus*, "Raspberry" | 1 | .25 |
| *Sarcocephalus esculentus*, "Cefalus" | 28 | 7.00 |
| *Spondias lutea*, "Mombin" | 25 | 6.25 |
| *Spondias minima* | 3 | .75 |
| *Spondias* sp | 6 | 1.50 |
| *Sterculia macrophylla* | 1 | .25 |
| *Terminalia buceras* | 1 | .25 |
| *Vanilla* sp | 8 | 2.00 |
| *Vitis rotundifolia*, "Muscadine grape" | 105 | 26.25 |
| *Trachylobium verrcosum* | 5 | 1.25 |
| *Terminalia edulis* | 2 | .50 |
| *Vanilla* sp | 25 | 6.25 |
| Vines, unidentified (P. O. No. 4292) | 27 | 1.35 |
| Unidentified plant | 2 | .10 |
| Unidentified sp | 1 | .05 |
| *Zalacca edulis* | 8 | 2.00 |
| *Ziziphus* sp | 1 | .25 |
| Total | 23,864 | 2,836.76 |

*Plants distributed from the Lamao Experiment Station from January 1 to December 15, 1916*—Continued.

| Name of plants. | Plants distributed. | Estimated value of plants distributed. |
|---|---|---|
| FIBER PLANTS. | | |
| *Agave cantala*, "Maguey" | 246,910 | $373.50 |
| *Agave sisalana*, "Sisal" | 15,300 | 23.00 |
| Total | 262,210 | 396.50 |
| ORNAMENTAL PLANTS AND SHADE TREES. | | |
| *Adenanthera pavonina* | 24 | 1.20 |
| *Albizzia* sp | 6 | .30 |
| *Albizzia moluccana* | 12 | .60 |
| *Areca rubra* | 49 | 12.25 |
| *Arundo donax* | 10 | .50 |
| *Bignonia grandiflora* (cuttings) | 300 | 15.00 |
| Bohol palm | 159 | 40.75 |
| *Caryota urens* | 32 | 8.00 |
| *Deguilla macrophylla* | 18 | .90 |
| *Heterosphate elata* | 22 | 1.10 |
| *Hyophorbe verschaffeltii* | 4 | 1.00 |
| *Leucaena glauca* | 24 | 1.20 |
| *Normanbya merrillii* | 8 | 2.00 |
| *Orania regalis* | 1 | .25 |
| Orchids unidentified | 20 | 15.00 |
| Pomegranate | 6 | .80 |
| *Richardia thurstoria* | 83 | 20.75 |
| *Roystonea borinquena* | 34 | 8.50 |
| *Washingtonia robusta*, "Washington palm" | 32 | 8.00 |
| Total | 844 | 137.60 |
| SUMMARY. | | |
| Economic plants | 23,864 | 2,836.76 |
| Fiber plants | 262,210 | 396.50 |
| Ornamental plants and shade trees | 856 | 137.60 |
| Grand total | 286,930 | 3,370.86 |

*Annual report of seed distribution for the year 1916.*

| Name of seeds. | Seeds distributed from Jan. 1 to Dec. 15, 1916. | |
|---|---|---|
| | Pounds. | Packages. |
| Beans: | | |
| Canadian Wonder | 1,546 | 24,736 |
| Cadyos | 25 | 300 |
| Castor oil | | |
| Kentucky Wonder | 614 | 9,724 |
| Lima | 429 | 6,864 |
| M. W. Wax | 648 | 10,368 |
| Patani | 451 | 7,216 |
| Beet | 102.6 | 13,132 |
| Cabbage: | | |
| American Variety | 40 | 10,291 |
| Amoy | 14 | 3,584 |
| Carrot | 34.6 | 8,858 |
| Coffee: | | |
| Abeocuta | 29 | |
| Canephora | 22 | |
| Excelsa | 91 | |
| Robusta | 75 | |
| Uganda | 19 | |
| Condol | .13 | 8 |
| Corn: | | |
| Moro | 9,240 | |
| Native yellow | 3,696 | |
| Cowpeas: | | |
| Black | 132 | |
| New Era | 7,656 | |
| Cucumber | 72.6 | 9,293 |
| Dhoura | | |
| Endive | 5 | 1,280 |
| Eggplant | 57 | 1,459 |
| *Eschscholtzia californica* | 3 | 192 |
| Eucalyptus | 1 | 256 |
| *Garllardia grandiflora* | 2 | 128 |
| Guar | 693 | |
| Indigo | 11 | |
| Ipil-ipil | 99 | |
| Kale | 10 | 2,560 |
| Kapok | 30 | |
| Kohlrabi | 5 | 1,280 |
| Lettuce | 32.3 | 8,272 |
| Lumbang | 178 | |
| Mongo: | | |
| Native | 2,215 | |
| Japanese | 62 | |

| Name of seeds. | Seeds distributed from Jan. 1 to Dec. 15, 1916. | |
|---|---|---|
| | Pounds. | Packages. |
| Mustard | 155 | 39,680 |
| Muskmelon | 7 | 896 |
| Okra | 48.2 | 6,168 |
| Onion | .41 | 80 |
| Onion sets | 80 | |
| Papaya | 8 | 1,024 |
| Peanuts in var., unshelled | 1,650 | |
| Peanuts Chinese, shelled | 209 | |
| Peas, Stratagem | 211 | 6,742 |
| Peas, Chinese | 66 | 1,056 |
| Pechay | 133 | 34,018 |
| Pepper | 26 | 6,659 |
| Pili | 310 | |
| Pumpkin | 38.7 | 2,476 |
| Radish: | | |
| Chinese | 181 | 23,168 |
| French breakfast | 10 | 1,280 |
| Roselle in varieties | 52 | 2,528 |
| Rutabaga | 20 | 5,720 |
| Seguidillas | 147 | 2,412 |
| Sincamas | 140 | |
| Sorghum | .88 | |
| Squash | 41.6 | 2,662 |
| Spinach | 20 | 5,120 |
| Sudan grass | 75 | |
| *Tagetes erecta* | 2 | 128 |
| Tobacco | 104 | |
| Tomato | 21 | 5,376 |
| Turnip | 23 | 5,888 |
| Uansoy | 2.2 | 141 |
| Watermelon | 26.7 | 1,708 |
| Wheat, Candeal | 12 | |
| Total | 32,109.62 | 274,728 |
| | *Cavans.*[a] | |
| Lowland rice: | | |
| Nonbearded | 353 | |
| Bearded | 35 | |
| Upland rice: Nonbearded | 567 | |
| Total | 955 | |

[a] One cavan equals 75 liters.

# PRELIMINARY REPORT ON THE VIRULENCE OF CERTAIN BODY ORGANS IN RINDERPEST.

By William Hutchins Boynton, *Pathologist.*

The following results were obtained while endeavoring to devise a method of securing the aggressins of rinderpest. Since the virus of rinderpest cannot at present be satisfactorily cultivated under artificial conditions it was decided to try extracting the virus from the tissues of animals suffering from this disease. From the symptoms, lesions, and microscopical findings, it is quite evident that the virus attacks primarily the involuntary muscles and endothelial lining of the capillary vascular system and the parenchymatous tissue. This is prominently demonstrated in the intestinal tract and in the lymphatic system. Upon microscopical examination of sections of intestine from an animal which has died of rinderpest it will be found that the capillary vascular system in the mucosa is flimsy. The vessel walls are stretched and distorted and lacking tone are unable to return to their normal shape. This weakened condition of the vessel walls leads to congestion, diapedesis of red blood cells and exudation of the blood plasma. As the plasma infiltrates into the sorrounding tissue it coagulates, resulting in coagulation necrosis and the formation of fibrinous casts which are constantly present in the colon of fatal cases. From the result obtained by the intravenous injection of various drugs and disinfectants (1) it is quite evident that the virus of rinderpest does not have its fountain head of development in the blood stream. The real place where the virus multiplies appears to be inside the tissue cells where the disinfectants can not penetrate, the virus in the blood stream being merely a surplus which is thrown off from these tissue cells. In following this line of reasoning it was decided to consider certain tissues where lesions were more or less pronounced, as cultures and extracts were made from them.

The tissues used in the following experiments were liver, spleen, lymph glands, heart, intestines, thymus, skeletal muscle, larynx, pharynx, and the back of the tongue from animals which

were either bled to death for virulent blood or from animals which had died after a regular course of the disease.

The tissues were taken from the animal as soon after death as possible. The amount of tissue desired was weighed, and ground in a meat grinder which had been previously sterilized in the autoclave to keep external contamination down to the minimum. The material thus prepared was placed in a sterilized flask and twice as much phenol solution (the strength of which will be mentioned in each experiment) was added. Both crude phenol and the pure crystal form were used in these experiments with similar results, i. e., 100 grammes of liver was ground and placed in a sterile flask and 200 cubic centimeters of a 0.5 per cent phenol solution added to it. This material was thoroughly agitated two or three times a day and kept in the refrigerator which averages between 15° and 16° Centigrade. In some experiments the material was placed in a shaking machine and agitated continuously for 48 hours at room temperature which averages 26° Centigrade in the morning and 28° Centigrade in the afternoon, some days rising to 30° Centigrade. After the 48 hours of agitation at room temperature the material was placed in the refrigerator for 24 hours and then filtered through gauze to separate out the coarse material and the filtrate replaced in the refrigerator until used.

When the intestines were to be extracted they were first thoroughly washed free from fecal matter, then placed in a 0.5 per cent phenol solution for from five to ten minutes after which they were placed in a large container of boiled water which was cooled down to at least 37° Centigrade. The tissue was allowed to soak in this water for a few minutes to dilute the phenol which remained intact. By this method a greater percentage of the bacteria on the surface of the intestinal mucosa were destroyed. Following this treatment the tissue was weighed, passed through the meat grinder and treated in a similar manner to the other tissues.

The animals used in these experiments were all highly susceptible. They were obtained from localities where to our knowledge rinderpest has never been introduced, or from localities where the presence of rinderpest has not been known for a considerable number of years. These animals were brought to the laboratory and placed under observation for various lengths of time, which will be mentioned in each experiment. During the period of observation in the quarantine shed and through the course of the experiment their temperatures were taken twice a day and their general appearance noted. While

under experimentation and until the first symptoms of disease appeared the animals were kept in an isolation shed. Usually one or more susceptible animals were among them to check up any accidental infection that might gain entrance from other sources than by inoculation. As soon as the first symptoms of disease made their appearance the animal thus affected was immediately transferred to the shed where the sick animals were held.

The following abbreviations will be used in the experiments: A. M., morning; P. M., afternoon; C., centigrade; D., diarrhea; E. L., eating little; N. E., not eating; D., E. L., diarrhea, eating little; D., N. E., diarrhea, not eating; V. B., virulent blood; P. C. W., animals used by the Phil. C. Whitaker antirinderpest serum plant.

### EXPERIMENT I.

Water extract of liver, spleen and lymph glands, 3 days old.

*Carabao 69.*—Known history prior to the experiment. Native Fuga carabao, 3 years old, received at the laboratory and placed in quarantine January 7, 1917. This animal was kept under observation thirty days before it was used, and at no time during this period did it present a high temperature or develop any symptoms of sickness.

February 6, 1917, carabao 69 was injected subcutaneously with 100 cubic centimeters of a 3-day-old water extract from the liver, spleen and lymph glands of carabao 66, which was bled to death on the third day of temperature for V. B. to be used in immunization work. Fifty grammes of each of these tissues were used and 300 cubic centimeters of water added and allowed to extract in the refrigerator. After three days extraction the material was filtered through gauze and 100 cubic centimeters of the filtrate was used in this experiment.

February 10, carabao 69 presented an afternoon temperature of 40.5° C.

February 11, A. M. temperature 40.3° C.; P. M. 40.8° C.; D., N. E.

February 12–13, D., N. E.

February 14, died, presenting typical symptoms and lesions of rinderpest.

### EXPERIMENT 2

Water extract of liver, spleen and lymph glands, 3 days old.

*Carabao 72.*—Known history prior to the experiment. Native Fuga carabao, 2 years old, received at the laboratory and placed in quarantine January 24, 1917. This animal was kept under

observation twelve days before it was used, and at no time during this period did it present a high temperature or develop any symptoms of sickness.

February 6, 1917, carabao 72 was injected subcutaneously with 100 cubic centimeters of the same extract as was used in experiment 1.

February 9, carabao 72 presented an afternoon temperature of 40.5° C.

February 10–12, D., N. E.

February 13, found dead in the morning. This animal presented typical symptoms and lesions of rinderpest.

From the results of these two experiments it will be noticed that the watery extract from the organs used was very potent, the incubation period being four and three days, respectively, and the various symptoms leading up to death were prompt in making their appearance after the initial rise in temperature.

EXPERIMENT 3.

Phenol (0.5 per cent) extract of liver and lymph glands, 5 days old.

*Carabao 75.*—Known history prior to the experiment. Native Fuga carabao, 2 years old, received at the laboratory and placed in quarantine January 24, 1917. This animal was kept under observation twenty-two days before it was used and at no time during this period did it present a high temperature or develop any symptoms of sickness.

February 16, 1917, carabao 75 was injected subcutaneously with 200 cubic centimeters of a 4-day-old 0.5 per cent phenol extract from the liver and lymph glands of carabao 73, which was bled to death on the second day of temperature for V. B. to be used in immunization work.

The extract was prepared as follows:

> Liver, 250 grammes; 0.5 per cent phenol, 500 cubic centimeters.
> Lymph glands, 200 grammes; 0.5 per cent phenol, 400 cubic centimeters.

These were placed in the refrigerator, filtered through gauze on the third day, and returned to the refrigerator. The material had a sweet odor, presenting no evidence of putrefaction.

February 20, carabao 75 presented an afternoon temperature of 39.5° C.

February 21, A. M. temperature, 39.5° C.

February 22–23, D., N. E.

February 24, found dead in the morning. This animal presented typical symptoms and lesions of rinderpest.

EXPERIMENT 4.

Phenol (0.5 per cent) extract of liver, spleen and lymph glands, 5 days old.

*Carabao 81.*—Known history prior to the experiment. Native Fuga carabao, 2 years old, received at the laboratory and placed in quarantine January 24, 1917. This animal was kept under observation thirty-four days before it was used and at no time during this period did it present a high temperature or develop any symptoms of sickness.

February 28, 1917, carabao 81 was injected subcutaneously with 200 cubic centimeters of 5-day-old 0.5 per cent phenol extract of the liver, spleen and lymph glands from carabao 77, which was bled to death on the second day of temperature for V. B. to be used in immunization work.

The extract was prepared as follows:

Liver, 250 grammes; 0.5 per cent phenol, 500 cubic centimeters.
Spleen, 175 grammes; 0.5 per cent phenol, 350 cubic centimeters.
Lymph glands, 135 grammes 0.5 per cent phenol, 270 cubic centimeters.

This was placed in the refrigerator for three days, then filtered through gauze and the filtrate returned to the refrigerator. When the extract was injected it had a sweet odor, presenting no evidences of putrefaction.

March 2, carabao 81 presented an A. M. temperature of 39.5° C; P. M., 40° C.

March 4–7, D., N. E.

March 8, found dead in the morning. This animal presented typical symptoms and lesions of rinderpest.

EXPERIMENT 5.

Phenol (0.5 per cent) extract of heart, 5 days old.

*Carabao 84.*—Known history prior to the experiment. Native Fuga carabao, 3 years and 2 months old, received at the laboratory and placed in quarantine January 24, 1917. This animal was kept under observation fifty-six days before it was used in this experiment. On March 8, 1917, it was injected with 10 cubic centimeters of culture material in which the virus of rinderpest had been inoculated. The animal presented no ill effects from this injection.

March 22, 1917, carabao 84 was injected subcutaneously with 200 cubic centimeters of a 5-day-old 0.5 per cent phenol extract of the heart from carabao 85, which was bled to death on the

fourth day of temperature for V. B. to be used in immunization work.

The extract was prepared as follows:

Heart, 200 grammes; 0.5 per cent phenol, 400 cubic centimeters.

This was placed in the refrigerator three days, filtered through gauze and the filtrate returned to the refrigerator. When this extract was used it had a sweet odor and presented no signs of putrefaction.

March 28, carabao 84 presented an A. M. temperature of 39.6° C.; P. M., 40.7° C.

March 29, D.

March 30, D., E. L.

March 31, this animal was bled to death for V. B. to be used in immunization work. It presented good lesions of rinderpest.

EXPERIMENT 6.

Phenol (0.5 per cent) extract of skeletal muscle, 5 days old.

*Carabao 88.*—Known history prior to the experiment. Polo carabao, 8 years and 4 months old, received at the laboratory and placed in quarantine March 3, 1917. This animal was kept under observation twenty-six days before it was used, and at no time during this period did it present a high temperature or develop any symptoms of sickness.

March 29, 1917, carabao 88 was injected subcutaneously with 200 cubic centimeters of 5-day-old 0.5 per cent phenol extract of skeletal muscle from P. C. W. carabao 263, which was bled to death on the first day of temperature for V. B. to be used for hyperimmunization work in the production of antirinderpest serum.

The extract was prepared as follows:

Skeletal muscle, 200 grammes; 0.5 per cent phenol, 400 cubic centimeters.

This was placed in the refrigerator three days, then filtered through gauze and the filtrate returned to the refrigerator.

When the extract was injected it had a sweet odor, presenting no evidence of putrefaction.

Carabao 88 did not developed any ill effects from this injection.

April 15, 1917, which was seventeen days after the muscle-extract injection, this animal was injected subcutaneously with 50 cubic centimeters of V. B. to test its susceptibility to rinderpest.

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April 19, this animal presented an afternoon temperature of 40.7° C.

April 21–22, D., E. L.

April 23–25, D., N. E.; blood and mucous casts in the feces.

April 26, found dead in the morning. This animal presented typical symptoms and lesions of rinderpest, which proves that it was highly susceptible to that disease when it was injected with the muscle extract. This result also leaves the impression that the virus of rinderpest is not harbored in the skeletal muscles, or it is easily destroyed in this tissue.

EXPERIMENT 7.

Phenol (0.5 per cent) extract of liver, spleen and lymph glands, 15 days old.

*Carabao 93.*—Known history prior to the experiment. Jolo carabao, 8 years and 4 months old, received at the laboratory and placed in quarantine March 3, 1917. This animal was kept under observation fifty-two days before it was used and at no time during this period did it present a high temperature or develop any symptoms of sickness.

April 25, 1917, carabao 93 was injected subcutaneously with 200 cubic centimeters of a 15-day-old- 0.5 per cent phenol extract of liver, spleen and lymph glands from P. C. W. carabao 251, which was bled to death on the second day of temperature for V. B. to be used for hyperimmunization work in the production of antirinderpest serum.

The extract was prepared as follows:

Liver, 200 grammes; 0.5 per cent phenol, 400 cubic centimeters.
Spleen, 200 grammes; 0.5 per cent phenol, 400 cubic centimeters.
Lymph glands, 200 grammes; 0.5 per cent phenol, 400 cubic centimeters.

This was placed in the refrigerator for three days, then filtered through gauze and the filtrate returned to the refrigerator. When the extract was injected it had a sweet odor, presenting no evidence of putrefaction.

April 29, carabao 93 presented an A. M. temperature of 39.2° C.; P. M., 40.2° C.

April 30, D.; P. M. temperature, 40.9° C.

May 1, D., E. L.

May 2–3, D., N. E.

May 4, found dead in the morning. This animal presented typical symtoms and lesions of rinderpest.

EXPERIMENT 8.

Phenol (0.5 per cent) extract of caecum and colon, 5 days old.

*Bull 4264.*—Known history prior to the experiment. Native Fuga bull, 4 years old, received at the laboratory and placed in quarantine April 12, 1917. This animal was kept under observation three days before it was used and did not present a high temperature or develop any symtoms of sickness during this time.

April 15, 1917, bull 4264 was injected subcutaneously with 100 cubic centimeters of a 5-day-old 0.5 per cent phenol extract of the caecum and colon from P. C. W. carabao 251, mentioned in experiment 7.

The extract was prepared as follows:

Caecum and colon, 200 grammes; 0.5 per cent phenol, 400 cubic centimeters.

This was placed in the refrigerator three days, then filtered through gauze and the filtrate returned to the refrigerator. When the extract was injected it had a sweet odor, presenting no evidence of putrefaction.

April 20, bull 4264 presented a P. M. temperature of 40.9° C.

April 21, P. M. temperature, 41.1° C.

April 22–23, D., N. E.

April 24, bled to death for V. B. to be used in immunization work. This animal presented typical symtoms and lesions of rinderpest.

EXPERIMENT 9.

Phenol (0.5 per cent) extract of larynx, pharynx and base of tongue, 5 days old.

*Bull 4265.*—Known history prior to the experiment. Native Fuga bull 4 years old, received at the laboratory and placed in quarantine April 12, 1917. This animal was kept under observation seven days before it was used, and did not present a high temperature or develop any symptoms of sickness during this period.

April 20, 1917, bull 4265 was injected subcutaneously with 100 cubic centimeters of a 5-day-old 0.5 per cent phenol extract of the larynx, pharynx and base of tongue from P. C. W. carabao 240, which was bled to death on the third day of temperature for V. B. to be used in immunization.

The extract was prepared as follows:

Larynx, 50 grammes; 0.5 per cent phenol, 100 cubic centimeters.
Pharynx, 50 grammes; 0.5 per cent phenol, 100 cubic centimeters.
Base of tongue, 50 grammes; 0.5 per cent phenol, 100 cubic centimeters.

This was placed in the refrigerator three days, then filtered through gauze and the filtrate returned to the refrigerator.

When the extract was injected it had a sweet odor, presenting no evidence of putrefaction.

Bull 4265 did not develop any ill effects from this injection.

May 7, 1917, which was seventeen days after the injection of the above-mentioned extracts, this animal was injected subcutaneously with 50 cubic centimeters of V. B.

May 10, bull 4265 presented its first rise in temperature, registering, A. M., 39° C.; P. M., 40° C.

May 11, A. M. temperature, 39.9° C.; bled to death for V. B. to be used in immunization work. This animal presented lesions found in the early stages of rinderpest. This proves that bull 4265 was susceptible to the disease when it received the injection of extracts. It also leads to the idea that the virus from these parts is either scarce or easily destroyed by the above method of handling, as it will be noticed in experiment 10 that other tissues from the same animal were virulent eight days after extraction.

### EXPERIMENT 10.

Phenol (0.5 per cent) extract of liver, spleen and lymph glands, 8 days old.

*Bull 4266.*—Known history prior to the experiment. Native Fuga bull, 3 years old, received at the laboratory and placed in quarantine April 12, 1917. This animal was kept under observation ten days before it was used, and did not present a high temperature or develop any symptoms of sickness during this period.

April 23, 1917, bull 4266 was injected subcutaneously with 50 cubic centimeters of an 8-day-old 0.5 per cent phenol extract of the liver, spleen and lymph glands from P. C. W. carabao 240, mentioned in experiment 9.

The extract was prepared as follows:

Liver, 150 grammes; 0.5 per cent phenol, 300 cubic centimeters.
Spleen, 150 grammes; 0.5 per cent phenol, 300 cubic centimeters.
Lymph glands, 100 grammes; 0.5 per cent phenol, 200 cubic centimeters.

This was placed in the refrigerator three days, then filtered through gauze and the filtrate returned to the refrigerator.

When the extract was injected it had a sweet odor, presenting no evidence of putrefaction.

April 26, bull 4266 presented its first rise in temperature, registering, A. M., 38.9° C.; P. M., 40.5° C.

April 28–30, D., N. E.

May 1–2, D., N. E.

May 3, found dead in the morning. This animal presented typical symptoms and lesions of rinderpest.

EXPERIMENT 11.

Phenol (0.5 per cent) extract of liver, spleen and lymph glands, 15 days old.

Three animals were used in this experiment, bulls 4269, 4270, and 4271. All these animals received a similar amount of the same extract on the same day and all gave similar results. Therefore, one only, bull 4269, will be considered.

*Bull 4269.*—Known history prior to the experiment. Native Fuga bull, 3 years old, received at the laboratory and placed in quarantine April 12, 1917. This animal was kept under observation twelve days before it was used, and did not present a high temperature or develop any symptoms of sickness during this period.

April 25, 1917, bull 4269 was injected subcutaneously with 200 cubic centimeters of a 15-day-old 0.5 per cent phenol extract of the liver, spleen and lymph glands from P. C. W. carabao 251, which was bled to death on the second day of temperature for V. B. to be used in immunization work.

The extract was prepared as follows:

Liver, 200 grammes; 0.5 per cent phenol, 400 cubic centimeters.
Spleen, 200 grammes; 0.5 per cent phenol, 400 cubic centimeters.
Lymph glands, 200 grammes; 0.5 per cent phenol, 400 cubic centimeters.

This was placed in the refrigerator three days, then filtered through gauze and the filtrate returned to the refrigerator. The liver extract had a slight butyric acid odor when it was injected; the others were sweet.

April 27, bull 4269 presented its first rise in temperature, registering, A. M., 39.1° C.; P. M., 40.3° C.

April 28, A. M. temperature, 40° C.; P. M., 41.2° C.

April 30, D., E. L.

May 1, A. M. temperature, 40.5° C.; bled to death for V. B. to be used in immunization work. This animal presented typical symptoms and lesions of a severe case of rinderpest.

Bulls 4270 and 4271 died of rinderpest during the morning of May 4. Both animals presented typical symptoms and lesions of rinderpest.

EXPERIMENT 12.

Phenol (0.5 per cent) extract of liver, spleen, parotid and lymph glands, 16 days old.

*Cow 4260.*—Known history prior to the experiment. Native Fuga cow, 2 years old, received at the laboratory and placed in quarantine April 12, 1917. This animal was kept under observation twenty-one days before it was used and did not present a high temperature or develop any symptoms of sickness during this period.

May 4, 1917, cow 4260 was injected subcutaneously with 200 cubic centimeters of a 16-day-old 0.5 per cent phenol extract of the liver, spleen, parotid and lymph glands from P. C. W. carabao 228, which was bled to death on the first day of temperature for V. B. to be used in immunization work.

The extract was prepared as follows:

Liver, 200 grammes; 0.5 per cent phenol, 400 cubic centimeters.
Spleen, 200 grammes; 0.5 per cent phenol, 400 cubic centimeters.
Parotid, 100 grammes; 0.5 per cent phenol, 200 cubic centimeters.
Lymph glands, 150 grammes; 0.5 per cent phenol, 300 cubic centimeters.

This was placed in the refrigerator three days, then filtered through gauze and the filtrate returned to the refrigerator. When the extract was injected it had a sweet odor, presenting no evidence of putrefaction.

May 7, cow 4260 presented its first rise in temperature, registering, P. M., 40.3° C.

May 10, N. E.

May 11–12, D., N. E.

May 13, found dead in the morning. This animal presented typical symptoms and lesions of rinderpest.

EXPERIMENT 13.

Phenol (0.5 per cent) extract of liver, spleen, parotid and lymph glands, 20 days old.

*Bull 4272.*—Known history prior to the experiment. Native Fuga bull, 2 years old, received at the laboratory and placed in quarantine April 12, 1917. This animal was kept under observation twenty-seven days before it was used, and did not present a high temperature or develop any symptoms of sickness during this period.

May 10, 1917, bull 4272 was injected subcutaneously with 200 cubic centimeters of a 20-day-old 0.5 per cent phenol extract of the liver, spleen, parotid and lymph glands from P. C. W.

carabao 228, the preparation of which is described in experiment 12. The liver extract had a slight butyric acid odor at the time of injection. The other extracts had a sweet odor and presented no evidence of putrefaction.

May 14, bull 4272 presented its first rise in temperature, registering, A. M., 39.4° C.; P. M. 40.4° C.

May 16–18, D., E. L.

May 19–20, D., N. E.

May 21, animal died early in forenoon, presenting typical symptoms and lesions of rinderpest.

EXPERIMENT 14.

Phenol (0.5 per cent) extract of liver, spleen and lymph glands, 15 days old.

*Carabao 92.*—Known history prior to the experiment. Native Jolo carabao, 3 years and 6 months old, received at the laboratory and placed in quarantine March 3, 1917. This animal was kept under observation fifty-two days before it was used and did not present a high temperature or develop any symptoms of sickness during this period.

April 25, 1917, carabao 92 was injected subcutaneously with 200 cubic centimeters of a 15-day-old 0.5 per cent phenol extract of the liver, spleen and lymph glands from P. C. W. carabao 251, which was bled to death on second day of temperature for V. B. to be used in immunization work.

The extract was prepared as follows:

Liver, 200 grammes; 0.5 per cent phenol, 400 cubic centimeters.
Spleen, 200 grammes; 0.5 per cent phenol, 400 cubic centimeters.
Lymph glands, 150 grammes; 0.5 per cent phenol, 300 cubic centimeters.

This was placed in the refrigerator three days, then filtered through gauze and the filtrate returned to the refrigerator.

When the extract was injected it had a sweet odor, presenting no evidence of putrefaction.

April 28, this animal presented its first rise in temperature, registering, A. M., 39.4° C.; P. M. 39.6° C.

May 1, D.; A. M. temperature, 39.8° C.; P. M. temperature, 41.1° C.

May 2–3, D., N. E.

May 4, D., E. L.

May 5, this animal's temperature was normal and it was well on the road to recovery.

June 1, carabao 92 received 50 cubic centimeters of V. B. which had no ill effect upon it, proving that the animal was immune to rinderpest. In addition, this animal was constantly exposed to animals in various stages of the disease.

From this result it appears that the virus in this case had become slightly attenuated by the extraction.

### EXPERIMENT 15.

Phenol (0.5 per cent) extract of liver, spleen and lymph glands, 29 days old.

*Carabao 104.*—Known history prior to the experiment. Native Jolo carabao, 7 years and 5 months old, received at the laboratory and placed in quarantine March 3, 1917. This animal was kept under observation seventy-one days before it was used and did not present a high temperature or develop any symptoms of sickness during this period.

May 14, 1917, carabao 104 was injected subcutaneously with 200 cubic centimeters of a 29-day-old 0.5 per cent phenol extract of the liver, spleen and lymph glands from P. C. W. carabao 240, which was bled to death on the third day of temperature for V. B. to be used in immunization work.

The extract was prepared as follows:

Liver, 300 grammes; 0.5 per cent phenol, 600 cubic centimeters.
Spleen, 300 grammes; 0.5 per cent phenol, 600 cubic centimeters.
Lymph glands, 150 grammes; 0.5 per cent phenol, 300 cubic centimeters.

This was placed in the refrigerator three days, then filtered through gauze and the filtrate returned to the refrigerator.

When the extract was injected the liver had a slight butyric acid odor. The other extracts were sweet, presenting no evidence of putrefaction.

May 24, which was ten days after the injection, carabao 104 presented an A. M. temperature of 39° C.; P. M., 39° C.

May 25, A. M. temperature, 39.4° C.; P. M., 41.3° C.

May 26, D., E. L.; A. M. temperature, 39.9° C.; P. M., 38.7° C.

May 27, the animal was eating well and its temperature registered normal. This animal rapidly recovered from the slight attack and to date has never presented any signs of rinderpest although constantly exposed to the disease.

From the results of this experiment it appears that the virus was markedly attenuated having just vitality enough to cause a slight onset of the disease, which lead to a speedy recovery.

EXPERIMENT 16.

Phenol (0.5 per cent) extract of pancreas, 5 days old.

*Carabao 107.*—Known history prior to the experiment. Native Jolo carabao, 5 years and 6 months old, received at the laboratory and placed in quarantine March 3, 1917. This animal was kept under observation eighty days before it was used and did not present a high temperature or develop any symptoms of sickness during that period.

May 23, 1917, carabao 107 received subcutaneously 100 cubic centimeters of a 5-day-old 0.5 per cent phenol extract of pancreas from P. C. W. bull 4, which was bled to death on the first day of temperature for V. B. to be used in serum production.

The extract was prepared as follows:

Pancreas, 100 grammes; 0.5 per cent phenol, 200 cubic centimeters.

This was placed in the refrigerator three days, then filtered through gauze and the filtrate returned to the refrigerator.

Carabao 107 never develop any ill effects from this injection.

June 13, which was 21 days after the pancreas-extract injection, carabao 107 received 50 cubic centimeters of V. B.

June 18, carabao 107 presented its first rise in temperature, registering, A. M., 39.8° C.; P. M., 40.6° C.

June 19, D.

June 20–21, D., N. E.

June 22, found dead in the morning This animal presented typical symptoms and lesions of rinderpest.

From this result it appears that the pancreas extracted in this manner is not virulent after five days.

EXPERIMENT 17.

Phenol (0.5 per cent) extract of liver, spleen, parotid and lymph glands, 55 days old.

*Bull 4285.*—Known history prior to the experiment. Native Fuga bull, 3 years old, received at the laboratory and placed in quarantine May 8, 1917. This animal was kept under observation thirty-four days before it was used, and did not present a high temperature or develop any symptoms of sickness during this period.

June 12, 1917, bull 4285 received subcutaneously 120 cubic centimeters of a 55-day-old 0.5 per cent phenol extract of liver, spleen, parotid and lymph glands from P. C. W. carabao 228. This extract was from the same lot used in experiment 12. At this time the liver extract had a slight butyric acid odor.

June 20, bull 4285 presented its first rise in temperature, registering, A. M. 39° C.; P. M., 40.5° C.

June 21, D.; A. M. temperature, 40° C.; P. M., 40.6° C.

June 22–24, D., N. E.

June 25, found dead in the morning. This animal presented typical symptoms and lesions of rinderpest.

From this result it appears possible to keep the virus in a virulent form for as long a period as fifty-five days in a 0.5 per cent phenol solution.

EXPERIMENT 18.

Phenol (1 per cent) extract of lymph glands 6 days old.

*Bull 4296.*—Known history prior to experiment. Native Fuga bull, 2 years old, received at the laboratory and placed in quarantine June 1, 1917. This animal was kept under observation seventeen days before it was used, and did not present a high temperature or develop any symptoms of sickness during this period.

June 18, 1917, bull 4296 received subcutaneously 100 cubic centimeters of 6-day-old 1 per cent phenol extract of lymph glands from P. C. W. bulls 1036 and 1037, which were bled to death on the second day of temperature for V. B. to be used in the production of antirinderpest serum.

The extract was prepared as follows:

Lymph glands, 200 grammes; 1 per cent phenol, 400 cubic centimeters.

This was placed in the refrigerator three days, then filtered through gauze and the filtrate replaced in the refrigerator.

June 22, bull 4296 presented its first rise in temperature, registering, A. M., 39.2° C.; P. M., 41° C.

June 24–27, D., N. E.

June 28, died in forenoon. This animal presented typical symptoms and lesions of rinderpest, which proves that a 1 per cent phenol solution will not destroy the virus of rinderpest in the lymph glands over a period of six days, nor does the virus appear to be attenuated by its presence.

EXPERIMENT 19.

Phenol (1 per cent) extract of liver, spleen, caecum and lymph glands, 17 days old.

*Bull 4299.*—Known history prior to experiment. Native Fuga bull, 2 years old, received at the laboratory and placed in quarantine June 1, 1917. This animal was kept under observation twenty-five days before it was used, and did not present a

high temperature or develop any symptoms of sickness during this period.

June 26, 1917, bull 4299 received subcutaneously 100 cubic centimeters of 17-day-old 1 per cent phenol extract of liver, spleen, lymph glands and caecum from P. C. W. bull 1034, which was bled to death on the first day of temperature for V. B.

The extract was prepared as follows:

Liver, 100 grammes; 1 per cent phenol, 200 cubic centimeters.
Spleen, 100 grammes; 1 per cent phenol, 200 cubic centimeters.
Caecum 100 grammes; 1 per cent phenol, 200 cubic centimeters.
Lymph glands, 100 grammes; 1 per cent phenol, 200 cubic centimeters.

This was placed in the refrigerator three days, then filtered through gauze and the filtrate returned to the refrigerator.

June 25, 50 cubic centimeters of each extract were added together making a total of 200 cubic centimeters; to this mixed extract was added 20 cubic centimeters of a 1–1000 per cent chlorazene solution and the resulting mixture returned to the refrigerator; on June 26, 100 cubic centimeters of this was taken for the injection of bull 4299.

July 1, 1917, bull 4299 presented its first rise in temperature, registering, A. M., 39.9° C.; P. M., 39.8° C.

July 2, A. M. temperature, 40.1° C.; P. M., 40.2° C.

July 3–5, D.

July 6, died in the forenoon, presenting good symptoms and lesions of rinderpest.

This shows that the 1 per cent phenol solution after acting seventeen days and the 1–1000 per cent chlorazene solution acting one day upon the mixed tissue extracts did not have any apparent detrimental effect upon the virus of rinderpest.

### EXPERIMENT 20.

Phenol (1 per cent) extract of lymph glands, 20 days old.

*Bull 4302.*—Known history prior to experiment. Native Fuga bull, 2 years old, received at the laboratory and placed in quarantine June 1, 1917. This animal was kept under observation twenty-eight days before it was used, and did not present a high temperature or develop any symptoms of sickness during this period.

June 29, 1917, bull 4302 received subcutaneously 100 cubic centimeters of a 20-day-old 1 per cent phenol extract of lymph glands from P. C. W. bull 1034 (see experiment 19).

July 2, this animal presented its first rise in temperature, registering, P. M., 40.2° C.

July 3, A. M. temperature, 39.6° C.; P. M., 40.2° C.

July 6–7, D., N, E.; died during the afternoon of July 7. This animal presented typical symptoms and lesions of rinderpest.

### EXPERIMENT 21.

Phenol (1 per cent) extract of liver, 21 days old.

*Bull 4303.*—Known history prior to experiment. Native Fuga bull, 3 years old, received at the laboratory and placed in quarantine June 1, 1917. This animal was kept under observation twenty-nine days before it was used, and did not present a high temperature or develop any symptoms of sickness during this period.

June 30, 19-17, bull 4303 received subcutaneously 100 cubic centimeters of 21-day-old 1 per cent phenol extract of liver from P. C. W. bull 1034 (see experiment 19).

This animal ran a rather erratic temperature from July 3 until death.

July 9, D.; P. M. temperature, 40° C., which was the highest temperature registered during the course of the disease.

July 10, D.

July 11, D., N. E.; P. M. temperature so low it could not be read.

July 12, found dead in the morning. This animal developed rather atypical symptoms which do some times occur in rinderpest (2). It presented good lesions of the disease.

### EXPERIMENT 22.

Phenol (1 per cent) extract of spleen, 21 days old.

*Bull 4304.*—Known history prior to experiment. Native Fuga bull, 2 years old, received at the laboratory and placed in quarantine June 1, 1917. This animal was kept under observation twenty-nine days before it was used, and did not present a high temperature or develop any symptoms of sickness during this period.

June 30, 1917, bull 4304 received subcutaneously 100 cubic centimeters of a 21-day-old 1 per cent phenol extract of spleen from P. C. W. bull 1034 (see experiment 19).

July 3, this animal presented its initial rise in temperature, registering, A. M., 39.4° C.; P. M., 40.6° C.

July 6–8, D., N. E.

July 9, died, presenting good symptoms and lesions of rinderpest.

It will be noticed from the results obtained in experiments 20, 21, and 22 that the 1 per cent phenol had apparently no

detrimental effect upon the virus of rinderpest when contained in the lymph glands, liver, and spleen for twenty and twenty-one days respectively.

EXPERIMENT 23.

Phenol (1 per cent) extract of lymph glands, 17 days old.

*Bull 4306.*—Known history prior to experiment. Native Fuga bull, 3 years old, received at the laboratory and placed in quarantine June 1, 1917. This animal was kept under observation thirty-eight days before it was used, and did not present a high temperature or develop any symptoms of sickness during this period.

July 9, 1917, bull 4306 received subcutaneously 100 cubic centimeters of a 17-day-old 1 per cent phenol extract of lymph glands from carabao 107, which died of rinderpest on the sixth day of temperature (see experiment 16).

The extract was prepared as follows:

Lymph glands, 200 grammes; 1 per cent phenol, 400 cubic centimeters.

This was placed in the refrigerator three days, then filtered through gauze and returned to the refrigerator.

This animal ran an atypical course of the disease. On July 10, P. M. temperature was 39.4° C., which was the highest temperature registered.

July 13–14, D., N. E.

July 15, found dead in the morning. This animal presented good physical symptoms and good lesions of rinderpest but did not develop a high temperature. The disease was very acute as the animal was dead on the morning of the sixth day after injection.

EXPERIMENT 24.

Phenol (2 per cent) extract of spleen, 5 days old.

*Bull 4316.*—Known history prior to experiment. Native Batanes bull, 6 years old, received at the laboratory and placed in quarantine June 3, 1917. This animal was kept under observation seventy-two days before it was used, and did not present a high temperature or develop any symptoms of sickness during this period.

August 15, 1917, bull 4316 received subcutaneously 50 cubic centimeters of a 5-day-old 2 per cent phenol extract of spleen from a P. C. W. bull which was bled to death for V. B. on its second day of temperature. This spleen extract was agitated at room temperature for forty-eight hours.

The extract was prepared as follows:

Spleen, 100 grammes; 2 per cent phenol, 200 cubic centimeters.

This was placed in a shaking machine and agitated continuously for 48 hours at room temperature. At the expiration of 48 hours it was placed in the refrigerator for 24 hours, then filtered through gauze and the filtrate returned to the refrigerator.

August 20, P. M. temperature, 39.8° C.

August 21, A. M. temperature, 38.7° C.; P. M., 39. 8° C.

August 22, A. M. temperature, 39° C.; P. M., 40.2° C.

August 25–26, E. L.

This animal was given 600 cubic centimeters of antirinderpest serum on August 21, 200 cubic centimeters on August 22, and 100 cubic centimeters on August 25. With the mildness of the attack and the administration of the serum the animal made a speedy recovery.

This animal was constantly exposed to animals sick with rinderpest and on September 13, 1917, was injected with 2,000 cubic centimeters of a 7-day-old 0.75 per cent phenol extract of liver and lymph glands, and never developed the disease, proving that it had been immunized by its first attack.

September 27, 1917, it was considered hyperimmune and bled to death for its serum.

This proves that the 2 per cent phenol and agitation did not destroy the virus of rinderpest but undoubtedly attenuated it to some extent.

### EXPERIMENT 25.

Phenol (2 per cent) glycerin extract of spleen, 5 days old.

*Bull 4308.*—Known history prior to experiment. Native Fuga bull, 3 years and 3 months old, received at the laboratory and placed in quarantine June 1, 1917. This animal was kept under observation seventy-four days before it was used, and did not present a high temperature or develop any symptoms of sickness during this period.

August 15, 1917, bull 4308 received subcutaneously 50 cubic centimeters of a 5-day-old 2 per cent phenol extract of spleen, to which glycerin was added, from P. C. W. bull mentioned in experiment 24.

The extract was prepared as follows:

Spleen, 100 grammes.
Glycerin, 50 cubic centimeters.
Water, 150 cubic centimeters.
Phenol (pure), 4 cubic centimeters.

This was placed in a shaking machine and agitated continuously for 48 hours at room temperature. At the expiration of 48 hours it was placed in the refrigerator for 24 hours, then filtered through gauze and the filtrate returned to the refrigerator.

Bull 4308 did not develop any symptoms of disease from this injection.

August 29, which was fourteen days after the extract injection, this animal was injected with 50 cubic centimeters of V. B.

September 1, this animal presented its first rise in temperature, registering, A. M., 39.5° C.; P. M., 40.1° C.

It ran a rather severe course of the disease and finally recovered.

This proves that the virus was destroyed in the spleen extract by the action of the 2 per cent phenol and glycerin.

Several similar experiments were tried using liver and lymph glands, and it was found that the virus was destroyed in each case where glycerin was added.

### EXPERIMENT 26.

Phenol (2 per cent) extract of lymph glands, 8 days old.

*Bull 4335.*—Known history prior to experiment. Native Fuga bull, 3 years old, received at the laboratory and placed in quarantine August 28, 1917. This animal was used on the day of its arrival so was not under observation previous to the experiment.

August 28, 1917, bull 4335 received subcutaneously 50 cubic centimeters of an 8-day-old 2 per cent phenol extract of lymph glands from P. C. W. bull 1660, which was bled to death on its second day of temperature for V. B.

The extract was prepared as follows:

Lymph glands, 100 grammes; 2 per cent phenol, 200 cubic centimeters.

This was placed in the shaking machine and agitated continuously for 48 hours at room temperature. At the expiration of 48 hours it was placed in the refrigerator 24 hours, then filtered through gauze and the filtrate returned to the refrigerator.

This injection had no ill effect upon bull 4335.

September 11, 1917, which was fourteen days after the 2 per cent phenol lymph gland extract injection, this animal received 50 cubic centimeters of a 5-day-old 0.75 per cent phenol extract of liver and lymph glands from carabao 97, which was bled to death for V. B. on its fourth day of temperature.

September 13, bull 4335 presented its first rise in temperature, registering, A. M., 39.6° C.; P. M., 39.8° C.

September 14, A. M. temperature, 40.2° C.; P. M., 40.3° C.

September 15, D.; bled to death for V. B. to be used in immunization work. This animal presented good symptoms and lesions of rinderpest.

This proves that the 2 per cent phenol and the agitation together destroyed the virus of rinderpest in the lymph gland extract after eight days.

Similar results were obtained by treating liver tissue in the same way and for the same length of time.

Heart and intestine extracts were found to lose their virulence in six days when treated in the above-mentioned manner.

## DISCUSSION.

From the results obtained in the foregoing experiments it is apparent that the virus of rinderpest held in certain tissues of the body is not injured when extracted with weak solutions of phenol. From many observations, which have been made in this laboratory during the past seven years it has been noticed that the virus of rinderpest is quickly destroyed in decomposing material, either tissue or blood. On the other hand if virulent blood is drawn under aseptic conditions and placed in sterile containers the virus will retain its activity for five or six days. If the blood is kept in a clotted form the virus retains its activity a few days longer. It has been shown in previous work (3) that when the large water leech (*Hirudo boyntoni*, Wharton) is allowed to feed upon an animal sick with rinderpest, the virus may remain active for a period of twenty-five days inside the body of the leech. In this case the blood is kept from putrefactive organisms and also in a semianaerobic condition.

By extracting certain organs with weak phenol solutions the activity of the putrefactive organisms is kept down to the minimum and thus they have little or no effect upon the virus of rinderpest.

Many times a certain method will work in the hands of the originator but when placed in other hands the same good results are not obtained. To check this, Dr. Ildefonso Patdu and Florencio Patenia have made these extracts with no supervision from the writer, and the results obtained from these extracts were similar to those obtained where the writer had had full supervision.

To prove that these extracts would work as readily upon animals not used in the laboratory, on three different occassions ex-

tracts were given to Dr. D. W. Shaffer and Mr. Thomas L. Bean to be used as virulent material on animals which were used in the production of antirinderpest serum in the Phil. C. Whitaker antirinderpest serum laboratory. Dr. Shaffer and Mr. Bean obtained as good results with the extracts as we have in the Research Laboratory which proves that these extracts work as readily upon animals outside of the laboratory.

These extracts have been used in the immunization stations in the provinces, under the supervision of Dr. Stanton Youngberg, Chief Veterinarian, and are reported upon in another article in this issue of the REVIEW. In preparing extracts for the provinces we use a 0.75 per cent phenol solution. For ordinary immunization work it is best not to use an extract over 15 days old, as there are other factors that enter in which are apt to delude. We have obtained a considerable number of very gratifying results with old extracts, which will be reported in a subsequent paper. On these occasions the animals presented no reaction to the injection. After a period of two weeks these animals were exposed to rinderpest by various methods, i. e., exposure to sick animals, inoculation with virulent blood, and inoculation with extracts. These animals presented no ill effects from the exposures to which they were subjected, showing that they had been immunized by the primary injection of extract.

From the results obtained by Dr. R. R. Birch (4) on "Hog Cholera Transmission Through Infected Pork," it is quite possible that tissue extracts can be used as readily in that disease as in rinderpest, thereby lowering the enormous expense of obtaining virulent material in the production of anti-hog-cholera serum.

The writer wishes to thank Dr. D. W. Shaffer for the privilege of securing various tissues used in these experiments from animals used by Dr. Shaffer in obtaining virulent blood in the process of making antirinderpest serum.

## CONCLUSIONS.

1. From the results obtained in experiments 1 and 2, it is evident that water extracts of the liver, spleen, and lymph glands 3 days old are highly infectious to susceptible animals.

2. From the results obtained in experiments 3 and 4, it is evident that a 0.5 per cent phenol extract of liver, spleen and lymph glands 5 days old is highly infectious to susceptible animals.

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3. From the result obtained in experiment 5, it is evident that a 0.5 per cent phenol extract of heart muscle 5 days old is highly infectious to susceptible animals.

4. From the result obtained in experiment 6, it appears that the skeletal muscle is not a suitable tissue for making extracts in the case of rinderpest.

5. From the results obtained in experiments 7, 10, 11, 12, 13, 14, 15, and 17 it is proved that a 0.5 per cent phenol extract of liver, spleen and lymph glands can hold the virus of rinderpest in a virulent form for periods of time varying from eight to fifty-five days.

6. From the result obtained in experiment 8, it is evident that a 0.5 per cent phenol extract of caecum and colon five days old is highly infectious to susceptible animals.

7. From the result obtained in experiment 9, it is apparent that the larynx, pharynx, and base of tongue are not suitable tissues for making extracts in the case of rinderpest.

8. From the result obtained in experiment 16, it is apparent that the pancreas is not a suitable tissue for making extracts in the case of rinderpest.

9. From the results obtained in experiments 18, 20, and 23 it is evident that a 1 per cent phenol extract of lymph glands, 6, 20, and 17 days old, respectively, are highly infectious to susceptible animals.

10. From the result obtained in experiment 19, it is evident that a 1 per cent phenol extract of liver, spleen, caecum and lymph glands 17 days old is highly infectious to susceptible animals.

11. From the result obtained in experiment 21, it is evident that a 1 per cent phenol extract of liver 21 days old is virulent to susceptible animals.

12. From the result obtained in experiment 22, it is evident that a 1 per cent phenol extract of spleen 21 days old is virulent to susceptible animals.

13. From the result obtained in experiment 24, it is evident that a 2 per cent phenol extract of spleen 5 days old is infectious to susceptible animals.

14. From the result obtained in experiment 25, it appears that when glycerin is added to a 2 per cent phenol extract which had been agitated for 48 hours the virus of rinderpest is readily destroyed.

15. From the result obtained in experiment 26, it appears that in a 2 per cent phenol extract of lymph glands 8 days old, the virus of rinderpest is destroyed.

16. From certain results mentioned in the discussion it is advisable to use a 0.75 per cent phenol extract not over 15 days old.

17. From the results obtained in working with rinderpest it is very plausible that similar or even better results may be obtained with the virus of hog cholera along these lines.

18. The tissues best adapted for this work are the liver, spleen, lymph glands, heart, fourth stomach, caecum, and colon.

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# PRACTICAL LABORATORY APPARATUS—FILTERING RACK FOR SUGAR SOLUTIONS.

By Cleve. W. Hines, *Sugar Technologist.*

In the successful execution of analytical sugar work, promptness and accuracy are two of the essentials. Unless analytical results of various sugar-factory products are immediately available while the material is in process they are valueless in the control of the manufacturing operations. While promptness is one of the essentials in obtaining serviceable results, absolute accuracy is quite often as important and in simultaneously carrying on a large series of analyses in control work it is necessary that every possible convenience be at hand to facilitate the work. It is also essential that space on the laboratory tables be so economized that the analyst be not required to move about from place to place in carrying on the various operations.

In the preparation of specimens for polarimetric work the first operation is to obtain a clear solution for the observation tube. It is the experience of every sugar chemist that the first filtrate which passes through the filter paper after the addition of the clarifying reagent is very cloudy due to the presence of more or less colloidal material. There is also quite often present traces of lint as well as moisture from the filter paper. The presence of this material results in delay in the obtaining of a clear filtrate and also in reducing the degree of accuracy in the polarimetric reading. The common custom of throwing away the first portion of the filtrate is unsatisfactory since traces of these colloidal bodies are certain to remain in the receiving glasses, however carefully the rinsing with new filtrate is done.

In order to eliminate this difficulty and at the same time provide a convenient rack which will permit a large number of samples to be analyzed consecutively without any danger of confusion of samples, the writer has employed with very satisfactory results the filtering rack shown in the accompanying figure. This apparatus also offers an economy in desk space

over the usual system and there is less opportunity for confusion of samples on the part of the laboratory assistants in preparing their specimens for analysis when a large rack of this type is provided and each funnel space is properly numbered and the sambles for each lot are grouped. The apparatus consists of a double filter rack the forepart being 16 centimeters from the top of the table while the second portion is 32 centimeters. The distance from the front to the back of the apparatus is 60 centimeters, each compartment being 30 centimeters in width. The length of the apparatus is determined by the number of filters it is desired to accommodate at one time. An outfit for twelve samples should be approximately 75 centimetrs long.

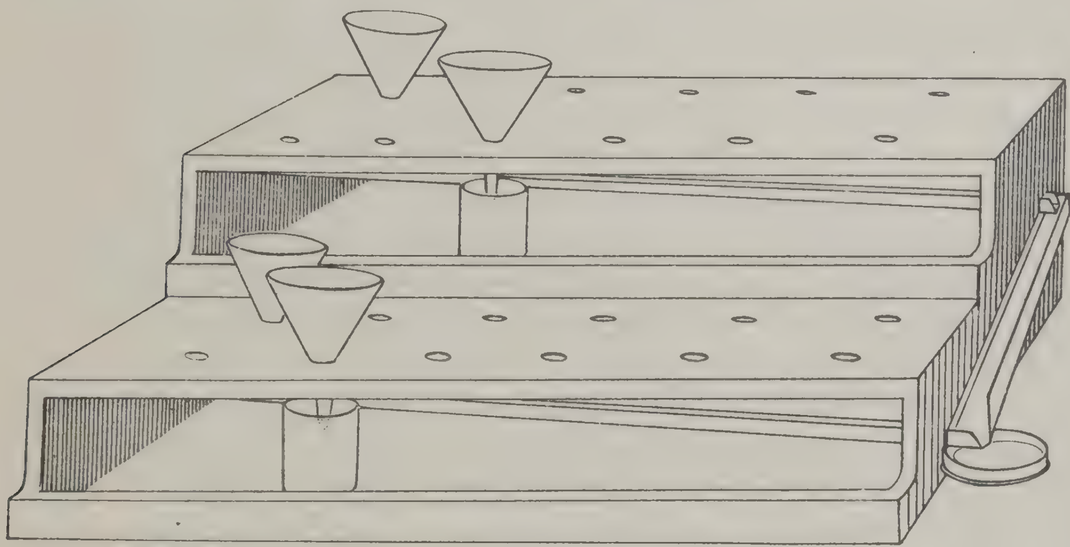

FIG. 2. Filtering rack for sugar solutions.

The shelf portion of each compartment is 24 centimeters wide and contains holes 2 centimeters in diameter, the first of these being located 7 centimeters from the side and the others 12 centimeters from the center of the previous hole.

The first row of holes is located 4 centimeters from the front edge and the second 7 centimeters from the back edge. Beneath the back row of holes in both the front and rear racks are placed small pans or troughs of galvanized iron which receive the first filtrate that passes. After the clear liquid has begun to pass through, the funnels are moved forward to the front row of holes and placed above the clean beakers to receive the filtrate for polarization.

# OBSERVATIONS ON THE IMMUNITY TO RINDERPEST OF THE NELLORE (INDIAN) CATTLE AND OF THE VARIOUS NELLORE-NATIVE GRADES.[1]

By STANTON YOUNGBERG, *D. V. M., Chief Veterinarian.*

During the year 1909 the Bureau of Agriculture purchased 12 head of first-class Nellore cattle, the shipment consisting of 101 young cows and 2 medium-aged bulls. These animals had been selected with great care at the annual Ongole cattle show in the district of Nellore, Madras Presidency, by Lieutenant-Colonel Gunn, M. R. C. V. S., Superintendent of the Civil Veterinary Department, Madras. The purpose was to ascertain if these cattle could readily adapt themselves to the climate, feed, and needs of this country, and also to determine if they could be used to improve the native breeds of cattle.

It was found that the Nellore cattle readily adapted themselves to the conditions in the lower altitudes of the Philippine Islands and that the crosses upon native and Chinese dams produced a very good type of animal.

The high resistance to rinderpest of the "plains" cattle of India has long been recognized. Lingard (1) states that "The cattle and buffaloes of the plains show varying degrees of immunity, so much so that especially in the United Provinces it would be impossible to utilize them for supplying virulent blood or for the purpose of testing the protective value of sera where a marked susceptibility is necessary in the animals utilized." Further that "it is well known that some plains animals in this country may pass through attacks of rinderpest of so slight a character, that it may even be overlooked by the initiated in this disease." He also ascertained that these plains cattle "require a dose (of serum) 15 to 18 times less than that required by the small hill animals per 600 pounds body weight."

Holmes (2) makes the following observations in regard to the plains cattle: "The plains cattle used for this experiment

[1] The following abbreviations are used in this article: V. B., virulent blood; D., diarrhea; D. M., diarrhea with mucus; E. L., eating little; N. E., not eating.

were inexpensive animals of ordinary village type. They were only slightly susceptible to rinderpest and few died during the process of serum preparation." Holmes (3) also states "All animals used for rinderpest-serum preparation are first of all passed through an immunizing process. Plains cattle are inoculated with virus and allowed to go through the normal course of the disease. In the laboratory very few plains cattle succumb to the disease. Buffaloes receive a small injection of serum from 5 to 10 c. c. according to their size at the same time as the virus, and pass through a modified attack."

By the year 1911 the idea seems to have become prevalent among the men breeding the Nellore cattle that they transmitted their resistance to rinderpest to their offspring when crossed upon native and Chinese dams. Several people, including members of this Bureau, were of the opinion that by importing cattle of Indian breeds and crossing them upon the native stock the rinderpest problem of the Philippine Islands would be solved. In an article entitled "Live stock and poultry in the Philippine Islands," which was published in the PHILIPPINE AGRICULTURAL REVIEW for September, 1911 (Vol. IV, pp. 485–486), the following statement is made: "Nellore cattle were introduced by the Bureau in 1909. They have been successfully raised, pure, at Alabang and La Carlota. At Baguio they do not seem to thrive as well as in the lowlands, owing, perhaps, to the cold rains. Nellore bulls have been crossed upon Chinese and native dams with very gratifying results. The resulting grades are of good size and conformation, and seem to be able to subsist on the natural pastures of the Islands. The fact that these Nellore cattle are seldom troubled by ticks, that they are very resistent to rinderpest, and that this resistance is transmitted to their offspring, should be important factors in recommending them for this country."

In the annual report of the Director of Agriculture for the fiscal year 1912–13 (PHILIPPINE AGRICULTURAL REVIEW, Dec., 1913, Vol. VI, pp. 599–600), the following statement appears in regard to the Nellore grades: "Of all the mestizos or grade cattle produced at this station, the Nellore-Chinese and native crosses (offspring from Nellore sires out of Chinese and native dams) are the most satisfactory. They are also much larger than the native or Chinese dams, and above all are immune or at least very highly resistant to rinderpest."

Edwards (4) conveys the same idea. "First among these characters should be mentioned their high resistance or apparent nearly complete immunity to rinderpest. Perhaps the greatest

value of this breed to the Philippine Islands lies in their use as a cross or factor for upgrading native stock and in this they promise to be very satisfactory. These crosses are highly resistant to rinderpest, are a great improvement in size and conformation over the native dams, and, in fact, exhibit to a surprising degree most of the desirable characteristics of the Indian."

Since the year 1909 further introductions of Nellore cattle have been made from time to time, and they are now being used to a great extent throughout the Islands for the upgrading of the native stock. Coincident with this extension of the use of Nellore cattle for breeding purposes the idea became disseminated that the grades are very highly resistant to rinderpest. There is no doubt but that many cattle raisers are under the impression that by the use of Nellore sires they can rid themselves of the menace of rinderpest.

During the years 1911–15 rinderpest was fairly well under control throughout the Archipelago and did not cause any serious losses among cattle and carabaos. Also the majority of the Nellore grades were located in those sections that for several years had suffered the least from this disease. During the past two years, however, there has been a considerable increase in the amount and virulence of rinderpest infection and some sections of the Islands have sustained rather heavy losses. The writer now began to hear reports of the death of Nellore grades from rinderpest. This would of course render untenable the theory of the high resistance of the Nellore-native grades, and led to an investigation of the soundness of and basis for this theory.

Lingard (5) makes the following statement with reference to the susceptibility of the half-breed animals in India: "The progeny of 'hills' and 'plains' require doses of serum approximating to those necessary for hill cattle, *viz.*, from 15 to 18 times the dose given to plains. The half-bred cattle are not so susceptible to rinderpest as 'hills,' but as it is imposible to compute the degree of susceptibility, in order to be on the safe side, the full dose for hill animals should be administered."

In view of the above it was decided to test the resistance of pure-bred Nellore cattle to the Philippine strain of rinderpest and also to make more careful tests and observations in regard to the resistance of the Nellore-native grades. Before doing this, such records of the Nellore and Nellore-native grades as are still available at the Alabang Stock Farm were carefully examined. Unfortunately no data could be found which dem-

onstrate the resistance to rinderpest of the above-mentioned animals.

In the latter part of June, 1916, a shipment of 51 Nellore cattle arrived from Singapore, consisting of 50 males from 1 to 3 years of age (the majority being about 1½ years), and 1 female about 7 years of age. On July 2, 1916, these animals were each injected with 25 cubic centimeters of virulent rinderpest blood without serum. Of the 50 young males, 43 showed a typical temperature reaction, the first rise taking place from the third to the fourth day after injection, the fever continuing from 4 to

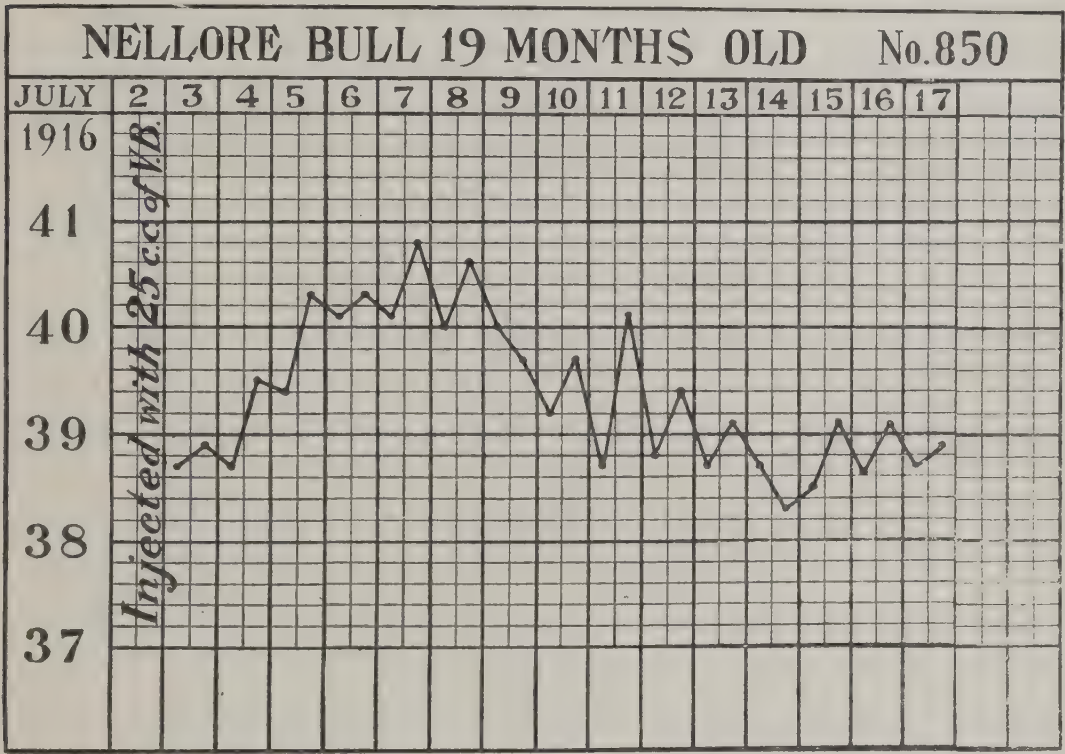


Chart No. 1.

8 days. Only 5 of these animals developed a diarrhea, which persisted from 2 to 3 days, the remainder showing no clinical symptoms except the fever curve. None of the animals stopped eating entirely, either during or after the period of reaction, although a few did not seem to greatly relish their feed for two or three days. There was no noticeable loss of condition among any of the animals. The aged female gave no reaction.

While the fever was at its height blood was drawn from two of the males (Nos. 850 and 866) which was mixed and 50 cubic centimeters injected into a susceptible native cow (No. 4028). The object was to ascertain whether the strain had become attenuated by being passed through the Nellore cattle. This animal developed its first rise of temperature the third day after

injection and died from typical rinderpest on the ninth day, demonstrating that the strain of virus had lost none of its virulence by injection into the Nellore cattle. This shows that Nellore cattle may be very pernicious factors in causing the dissemination of rinderpest, since while passing through the reaction they ordinarily do not present any pronounced symptoms of the disease, and consequently might be moved from place to place and thus infect other animals.

On March 3, 1917, a shipment of 332 head of Nellore cattle arrived at Manila. These animals had been collected in India,

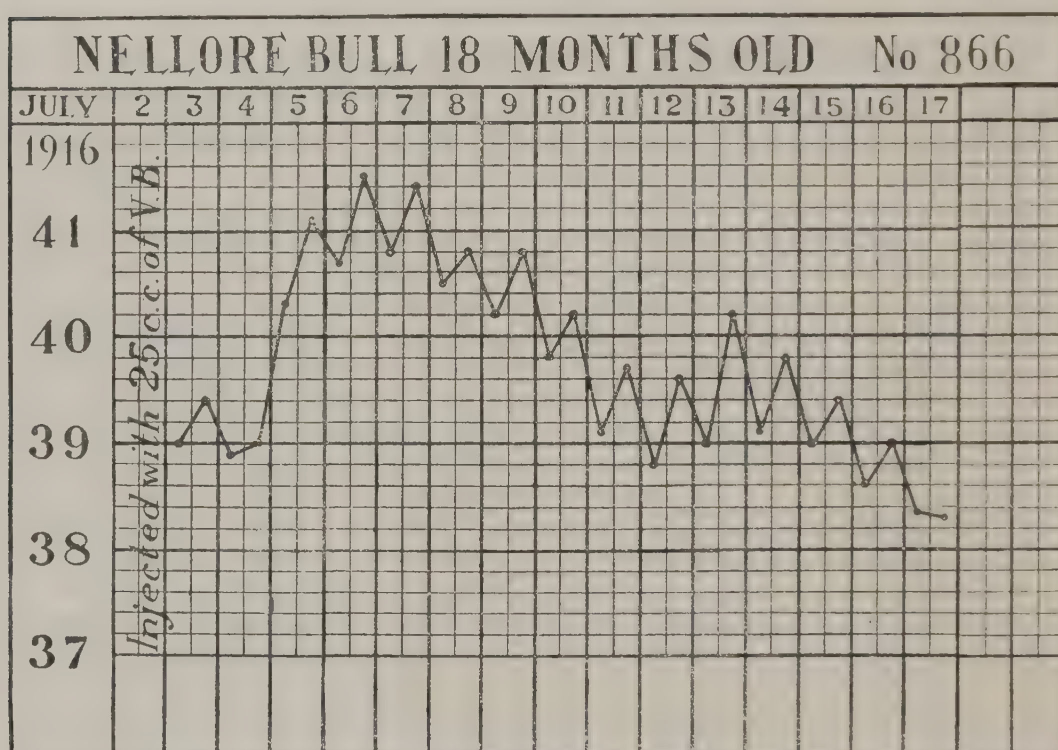


CHART NO. 2.

taken to Singapore in small lots, and held there for several weeks awaiting shipment. Three days after arrival some of these animals developed foot-and-mouth disease, which proved to be of a fairly virulent nature and eventually spread through the entire lot. It was therefore necessary to hold them until they had recovered from foot-and-mouth disease before giving them the injections of virulent rinderpest blood. Of these animals 285 were from 1 to 2 years of age (the majority of them being around 18 months), four were suckling calves, 26 were from 3 to 7 years, and 17 were over 7 years. April 4, 1917, 201 head were injected with 10 cubic centimeters of virulent blood, and the remaining 131 were injected with the same amount on April 28. As a result of these injections 131 showed the typical rinderpest

fever curve while several others undoubtedly reacted, though showing rather irregular temperatures. One hundred and twenty of these reactions were among the animals from 1 to 2 years of age. The suckling calves showed no reaction. No deaths occurred and there were only a few transient cases of diarrhea and inappetence. The percentage of reactors in this shipment was lower than in the first lot. There is a possibility that several of the cattle might have passed through the disease in India or during the long period in Singapore while awaiting shipment.

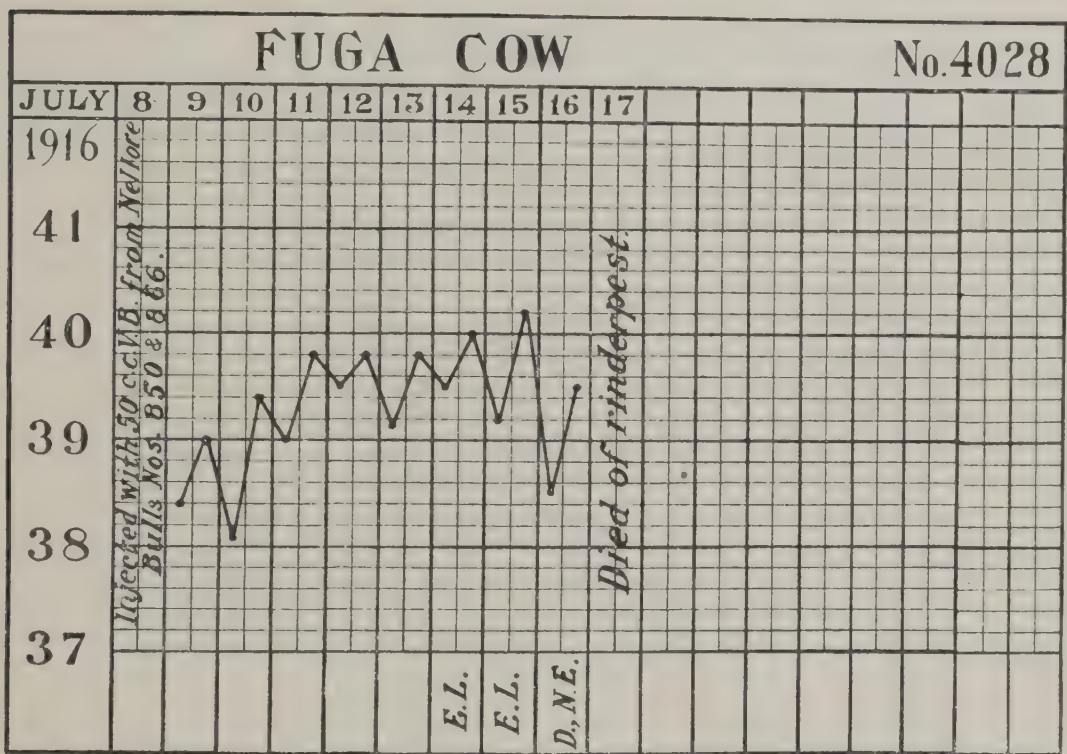


CHART No. 3.

Mr. Phil. C. Whitaker received a shipment of 19 Nellore cattle in the latter part of August, 1917, which consisted of 13 bulls and 6 cows from $1\frac{1}{2}$ to 6 years of age. On August 28, they were each injected with 20 cubic centimeters of virulent blood. The injections were performed by Dr. D. W. Shaffer and Mr. Thomas L. Bean, employed by Mr. Whitaker, under the supervision of this office. All of these animals reacted to the injection, one of them (No. 1789) succumbing on the ninth day after injection. Fifty per cent developed diarrhea while the animal that died passed a considerable quantity of mucus. Two of the females aborted.

Mr. Thos. L. Bean, while working at the Hacienda Pintong Sapang (a stock farm about 16 miles from Manila) in the month

of April, 1917, had had placed in his care 14 half-bred Nellore-native cattle about 5 years of age. Six of them contracted rinderpest from natural infection. They reacted severely, and one died. The other eight were each injected simultaneously with 10 cubic centimeters of virulent blood and 200 cubic centimeters of antirinderpest serum. Even with this large dose of serum all gave pronounced reactions, developing vesicles and ulcers in the buccal cavity and a bloody diarrhea.

During April, 1917, rinderpest made its appearance in the Province of Zamboanga. Dr. P. H. Burnett, formerly of the

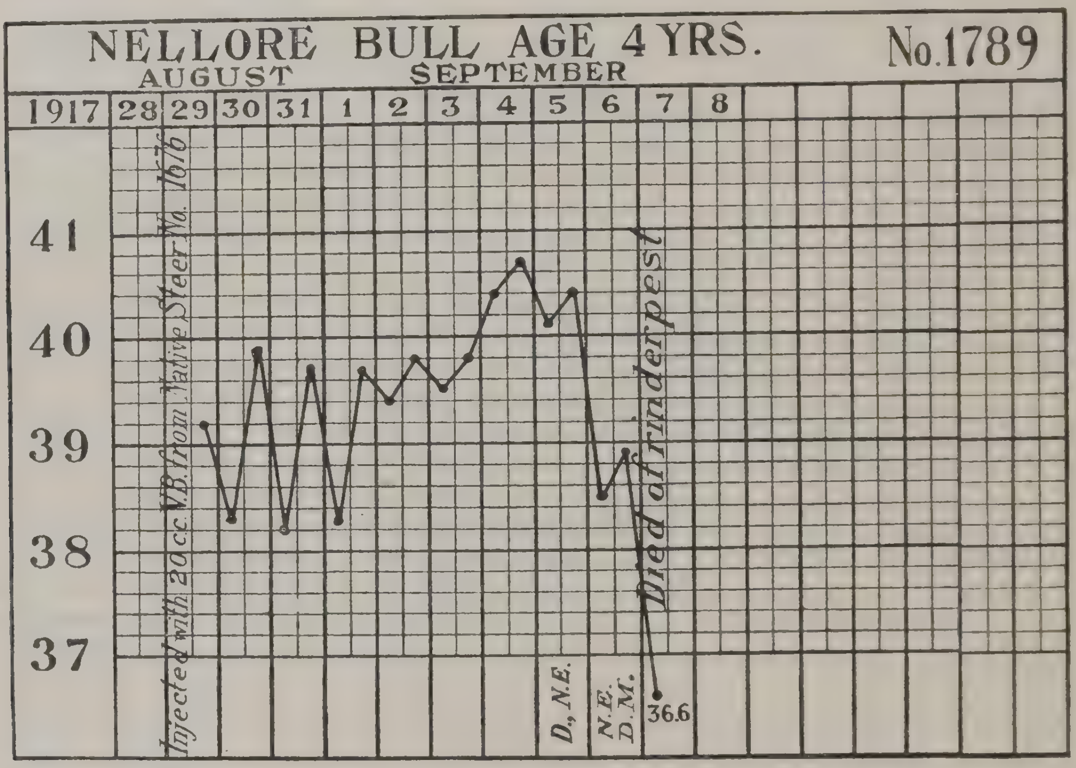


CHART NO. 4.

Bureau of Agriculture, was there at the time and observed its ravages among the Nellore-native grades. One plantation had a herd of 203 head consisting of native cows and Nellore-native grades, also a herd of about 50 pure Nellores. He reports that out of the 203 about 177 died. The mortality in the half-bred Nellore-natives was as high as that of the pure native cattle. He observed a three-quarter Nellore-native that was very sick for several days, but finally recovered. No full-blood Nellores died.

In the month of June, 1917, Mr. Whitaker brought to Manila from his ranch on the Island of Mindoro 42 half-bred Nellore-native bulls. This section of Mindoro is supposed to have never

been infected with rinderpest, and it is definitely known that this disease has not been present there during the past fifteen years. As these bulls were to be used for breeding purposes, Mr. Whitaker decided to have them immunized against rinderpest. They were from 4 to 6 years of age and averaged from 800 to 1,000 pounds in weight. The immunization was performed by Dr. D. W. Shaffer, the veterinarian in charge of Mr. Whitaker's antirinderpest serum laboratory. On June 19 each bull was injected with 5 cubic centimeters of virulent blood and 100 cubic centimeters of antirinderpest serum, as a result of which every one

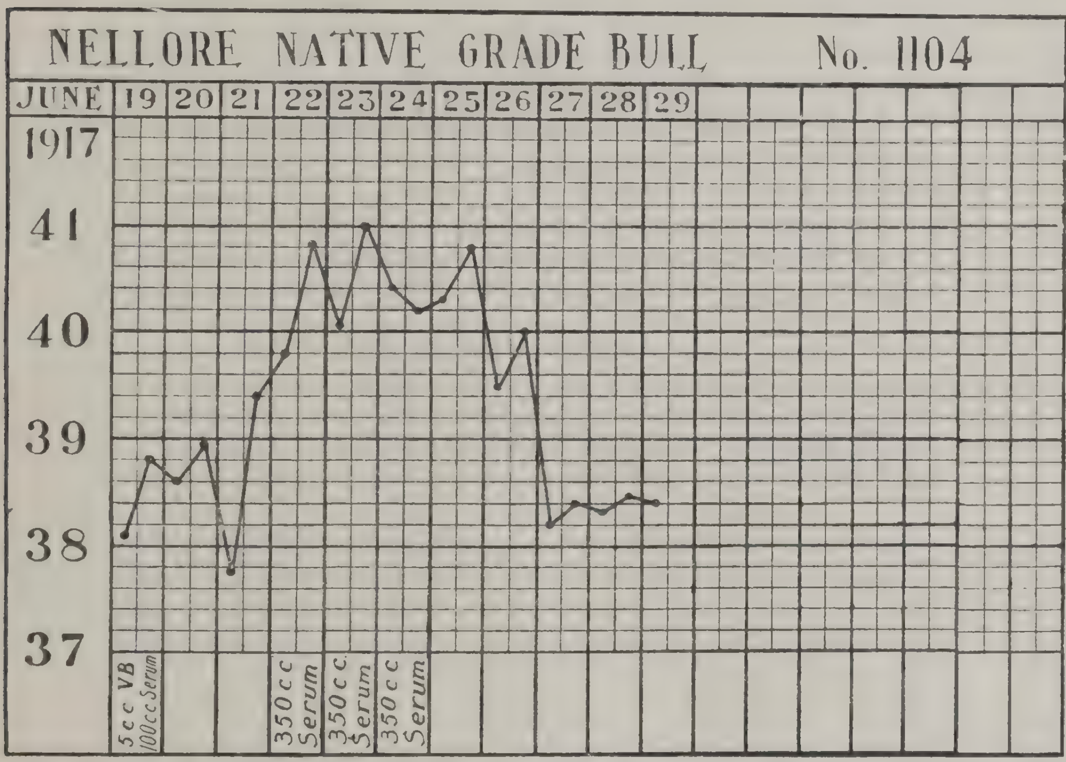


CHART No. 5.

gave a distinct reaction, beginning on the third day after injection in 25 animals, on the fourth day in 16, and on the fifth day in one. The duration of the period of fever was four days in 7 animals, five days in 12, six days in 15, and seven days in 8. (Charts Nos. 5 and 6 show two typical cases). As the rises of temperature took place in such a short time after the simultaneous inoculation in spite of the fact that 100 cubic centimeters of serum had been employed, Dr. Shaffer feared that severe reactions with considerable mortality might result, which was not desired as they were considered to be valuable animals. He therefore began the administration of additional serum in huge doses. Thirty-nine of the bulls received 350 cubic centi-

meters each on two successive days, while three received this dose for three successive days. Fortunately no mortality resulted.

In the month of July, 1917, in some manner not yet determined, rinderpest was introduced into the Island of Mindoro. This was in the same locality from which were brought the Nellore-native grades referred to above. Dr. H. F. Kern of this Bureau was sent there to take charge of the measures for the control of the plague, which was of a very virulent nature. One company had a breeding herd of 450 cattle which became infected in spite of

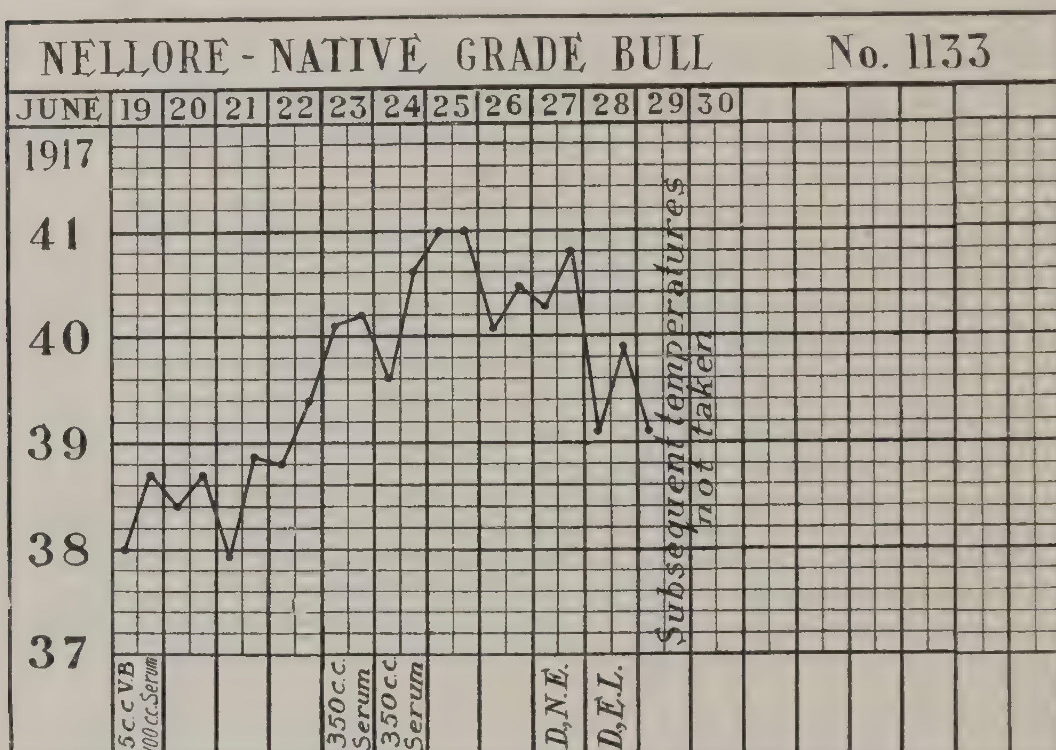


Chart No. 6.

the fact that they were kept in a fenced pasture. Dr. Kern reports that 210 of this herd succumbed to rinderpest. In this report he states the following: "They have had an Indian bull in this herd for some six years and at least 25 per cent show Indian blood, but several of these died while others that did not show the least trace of Indian blood lived." He also reports in regard to one man who had 18 half-bred Nellores which became infected with rinderpest, nine head dying from this disease.

Mr. F. W. Carpenter has a ranch located at Novaliches, Rizal Province, about 12 miles north of Manila. His herd consists of native and Indo-Chinese females, Nellore bulls, and grade offspring resulting from these crosses. The total number of

animals in the herd is around 370 of which about 300 are Nellore grades. During the month of October these cattle became infected with rinderpest, and up to date (November 5, 1917) about 135 head have died.

These facts prove that the one-fourth and one-half Nellore-native grades do not inherit the high degree of resistance to rinderpest possessed by the pure Nellores. From the meager information available it appears that the three-fourth grades may possess a resistance more closely approximating that of the Nellore. However, further observations will have to be made in regard to this point before definite conclusions can safely be drawn. Also there is the possibility that even the pure Nellore on being bred and raised in rinderpest-free areas for a few generations might lose its high resistance to the disease. The plains cattle of India undoubtedly owe their resistance to having been in constant contact with rinderpest for countless generations. Nevertheless they have not acquired an absolute immunity. The Annual Administration Report of the Civil Veterinary Department, Madras Presidency, for 1914–15 shows that rinderpest was unusually severe in several districts during that year, causing a total mortality of 23,341 of which 6,177 occurred in the district of Nellore. This was a much greater number of deaths from rinderpest than occurred in any one of the other 23 districts of the Madras Presidency. It states that, "The disease was of such a severe type that instructions were issued to the staff to use a double dose of serum invariably, and this accounts for the large amount of serum which was used during 1914–15."

Shilston (6) states that "the standarized dose of serum for plains cattle is taken at 5 c. c. per 600 pounds body weight." He also speaks of having produced batches of serum that were protective in doses of 1.5 c. c. per 600 pounds body weight for plains animals. From the results obtained by us in injecting Nellore cattle with virus alone, one would incline to the belief that the favorable results obtained by Shilston with such small doses of serum would be due more to the naturally high degree of resistance of the animals than to the serum employed. The virus employed by us was of a strain which when injected into susceptible native cattle produced the first rise of temperature in from 2 to 4 days after inoculation and death in from 7 to 10 days. However, there must be cattle in the district of Nellore less resistant than those with which we have worked, or the strain of rinderpest in that district must be more virulent, to

account for the 6,177 deaths which occurred in Nellore in 1914–15.

There are districts in the Philippine Islands, for instance, the Island of Negros, from which reports have been received from time to time from different owners of Nellore-native grades stating that rinderpest had made its appearance in their locality and that they had lost some of their native stock but none of the grades, though frequently the latter had shown signs of being "off" for a few days. The rinderpest in those districts has been of a very mild type, however, causing only small losses even among the native animals, and it is possible that the Nellore-native grade has a somewhat higher resistance than the pure native animal against strains of rinderpest of low virulence. The stockman must, however, take into account the fact that frequently rinderpest of low virulence unaccountably changes into a strain of high virulence which causes heavy mortality, and that he cannot then place much more reliance upon the resistance of the Nellore grades than upon that of the native stock.

## CONCLUSIONS.

1. The pure Nellore cattle are very highly resistant to the Philippine strains of rinderpest, the mortality being insignificant. They are not, however, absolutely immune.

2. In the case of native cattle, the infectivity of the virus is not appreciably attenuated by being passed through Nellore cattle. This fact makes the latter very dangerous as conveyors of the disease, as they may react without showing clinical evidence.

3. The half-bred Nellore-native cattle do not inherit the high degree of resistance to rinderpest possessed by the Nellore stock. In infections of moderate virulence they apparently have somewhat more resistance than the native animals, but in virulent infections this resistance does not afford them any protection.

4. From the inconclusive evidence, at hand, the three-fourths Nellore-native grades appear to have a greater resistance than the native stock.

5. The rinderpest problem of the Philippine Islands can not be solved by the importation of Nellore or other Indian cattle, unless possibly by carrying it out to the extent of practically eliminating the native stock.

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# NOTE ON THE USE OF ORGAN EXTRACTS IN PLACE OF VIRULENT BLOOD IN IMMUNIZATION AND HYPERIMMUNIZATION AGAINST RINDERPEST.

By William Hutchins Boynton, *Pathologist.*

In a paper appearing in this number of the REVIEW it will be noted that after an animal has been bled to death for virulent rinderpest blood, weak phenol extracts can be made from the liver, spleen, lymphatics, heart, and intestinal tract, and that these extracts are as potent as virulent blood.

One of the problems in the production of antirinderpest serum is the reduction in the cost of producing virulent material to be used in hyperimmunization. Various methods have been used with more or less success. Nicolle and Adil-Bey (1) were the first to develop a method by which the virulent material could be increased. When an infected animal presented symptoms of diarrhea they introduced into the peritoneal cavity a mixture composed of 3 volumes of normal saline solution and 1 volume of a slightly alkaline solution of Martin peptone. They introduced 6 liters of this material into yearling cattle (the quantity varying according to the size of the animal) and after three hours the animal was bled to death, the peritoneal cavity opened and the fluid aspirated. After allowing this fluid to coagulate, the clear liquid was drained off and used. The fluid thus obtained gave an increase in virulent material which was used with success in hyperimmunization.

Reudiger (2) obtained equal results using normal saline solution which he allowed to remain in the peritoneal cavity one to two hours before bleeding the animal to death and withdrawing it. The same author (3) also used a 5 per cent sodium-citrate solution with equal results.

Holmes (4) diluted the virulent blood with an equal volume of potassium-citrate solution and claims the diluted blood gave better results than undiluted defibrinated blood.

Martoglio (5) has developed the latest method in which he

claims to increase the virulent material about 70 per cent. His technique is as follows:

> When the infected bovine presents the buccal lesions, usually at the end of the fourth or fifth day of the fever, less commonly at the end of the third, sixth, or seventh, it is immobilized in the stocks and intubed in the jugular and the carotid on the same side. The jugular is put in communication with a capacious glass receptacle placed on a level with the head of the animal and containing saline solution, sterilized and at a temperature of 38° to 39°C., leaving the outlet tube of rubber closed by compression of pincers. * * * The carotid is put in communication with the receptacle which receives the pest blood, and the bleeding begins.
>
> When the convulsions preceding the death-struggle begin, the bleeding should stop. The assistant shuts the tube for drawing the blood with a clamp and opens the tube admitting the sodium-chloride solution; immediately the serious symptom-complex changes, the muscular contractions begin to cease, the respiration and pulse that were accelerated become regular and the animal when it has received about as much solution as it has lost blood, enters a period of calm.
>
> * * * * * * *
>
> We usually inject enough solution to make two and a half times the volume of blood taken, and without ill results. * * * The operation over the animal returns to its shed without assistance. After a lapse of about 5 or 6 hours the animal is bled from the same carotid, this time until it dies.

By this method Martoglio claims to wash out the blood vessels and lymphatic system and obtain a potent virus.

Dr. Stanton Youngberg, Chief Veterinarian, Bureau of Agriculture, and Dr. D. W. Shaffer, formerly in charge of the Phil. C. Whitaker antirinderpest serum laboratory, Manila, have been using a simple method of slightly increasing the production of virulent blood, as follows: The injected animal is bled from 2 to 4 liters of blood, depending upon its size, on the second day of temperature; the animal is then allowed to stand over night, during which time the body has an opportunity to replace the volume of the blood lost; on the following day it is bled to death. In the final bleeding practically as much blood in bulk is obtained as would be procured in a single bleeding, which gives an increase in virulent material corresponding to the amount obtained at the initial bleeding.

### TISSUE-EXTRACT METHOD.

Any of the above-mentioned methods can be utilized and an enormous increase of virulent material still be obtained by extracting the organs in a weak phenol solution. To illustrate this point we will consider the data obtained from an animal of ordinary size, which was bled to death and extracts made from its tissues.

Batanes bull 4318, bled to death August 24, 1917.

Amount of virulent blood obtained, 9,000 cubic centimeters.

Weight of organs from which extracts were made:

| | Grammes. |
|---|---|
| Liver | 1,735 |
| Spleen | 350 |
| Lymphatics | 260 |
| Fourth stomach | 320 |
| Caecum and colon | 2,220 |
| Heart | 680 |
| Total | 5,565 |

These organs were passed through a meat grinder and placed in twice their bulk of a 0.75 per cent phenol solution. That is, the caecum, colon, and fourth stomach were first thoroughly washed free from fecal mater, then placed in 5 per cent phenol solution for from five to ten minutes, after which they were placed in a large container of boiled water which was cooled down to at least 37° C.; these tissues were then allowed to soak in this water for a few minutes to dilute the phenol which remained intact (by this method a greater percentage of the bacteria on the surface of the intestinal mucosa is destroyed); following this treatment the tissue was weighed, passed through the meat grinder, and treated in a similar manner to the other tissues (5,565 grammes of tissue from this animal $\times$ 2 $=$ 11,130 cubic centimeters, the amount of phenol solution which should be added); this material was allowed to extract three days in the refrigerator, being thoroughly agitated three or four times each day; at the expiration of this period it was filtered through gauze to separate out the coarse material, the filtrate returned to the refrigerator, and was ready for use.

From the above-mentioned animal about 11 liters of extract filtrate would be obtained, plus the 9 liters of blood, which would make a total of 20 liters of virulent material, whereas under ordinary conditions but 9 liters would have been secured.

If this animal had been handled by the method advanced by Martoglio a still greater amount of virulent material would have been obtained. Considering that he obtains a 70 per cent increase in the virulent blood it would bring the total up to 26,300 cubic centimeters which would practically triple the output of virulent material from this animal, providing it had merely been bled to death.

Both simultaneous immunization and hyperimmunization work have been accomplished with these tissue extract at the laboratory and in the immunization stations in the provinces.

Dr. Youngberg had the extracts used in simultaneous immunization of carabao at the immunization station at Lubao, Pampanga Province, Dr. Topacio doing the work. These extracts were tried on two different sets of animals.

July 22, 1917, seventeen head of carabao were brought to the station for immunization and were injected with mixed liver, spleen and lymph gland extract in a 0.5 per cent phenol solution 5 days old. The doses administered and the final results were as follows: Eight animals received 5 cubic centimeters each of this extract, five animals giving good reactions; four animals received 10 cubic centimeters each of the extract, all of them giving good reactions; two animals received 15 cubic centimeters each of the extract, neither one reacting; two animals received 20 cubic centimeters each of the extract, one reacting; one animal received 25 cubic centimeters of the extract without reacting. On August 5, 1917, all the animals which did not react were injected with 25 cubic centimeters of virulent blood and none of them developed the disease, proving them to be immune. When these animals were injected with the extract they also received from 250 to 600 cubic centimeters of antirinderpest serum, the amount of serum administered depending upon the size of the animal.

August 17, 1917, fifteen head of carabao, brought into the station for immunization, received 5 cubic centimeters each of an 8-day-old liver extract which had been prepared as follows: Two hundred grammes of liver from an animal bled to death on the second day of temperature were passed through a meat grinder and 400 cubic centimeters of a 0.75 per cent phenol solution added to it; this material was placed in the refrigerator and thoroughly agitated three or four times a day; after three days extraction it was filtered through gauze and the filtrate returned to the refrigerator where it was kept until it was 7 days old. The extract was then shipped to the Lubao immunization station for use in the above injections. Of these fifteen animals, seven developed good reactions. Each of these animals received from 400 to 600 cubic centimeters of antirinderpest serum, depending on its size, at the same time the extract was injected. One of the reacting animal which received 400 cubic centimeters of antirinderpest serum succumbed to the disease, while the others made good recoveries. The animals which did not react were injected with 25 cubic centimeters of virulent blood on September 2, 1917, and one developed the disease from the second injection. There is a possibility that this animal did not contract the disease from the extract injection on account of a slight fault

in the technique of administering it. Since the skin of a carabao is thick it is difficult to use such a small injection as 5 cubic centimeters and be sure one has good penetration of the virus. When working with this type of animal it is best to give at least 10 cubic centimeters at an injection. If but 5 cubic centimeters of the material is desired it can easily be diluted up to 10 cubic centimeters with 0.85 per cent sodium-chloride solution without affecting the activity of the virus, and in this way one has the necessary bulk of material to work with.

The animals on which the extract was used were the ordinary type one has to handle in the immunization stations, as they were obtained from localities where rinderpest had been present for a number of years and many of those brought to the station had passed through the disease by natural contact. Since at present there is no way of identifying the immunity, all animals are subjected to the same treatment. This accounts for the high percentage of nonreactors obtained in this work. From the results obtained by the use of extracts, Dr. Youngberg states that it has the same efficiency as the most potent virulent blood. With a strong strain of virulent blood he usually obtains about 50 per cent reactors on the first injection. With the extract, slightly over 50 per cent of reactions were obtained, or in other words it picked out all the susceptible animals but one. The possible reason for this one not becoming infected from the extract has been mentioned.

In using the extract for hyperimmunization we have obtained some very satisfactory results, but there have been a few instances where the massive injection of this highly virulent material has resulted in the death of the animal. The possible causes for this will be discussed in connection with these animals.

The first hyperimmunization work with tissue extracts was accomplished by Dr. Patdu, upon Chinese cattle. These animals were imported into the Philippines to be used as work animals. Before they could be shipped to the provinces they had to be immunized against rinderpest, which was accomplished at the quarantine station.

Fourteen of these Chinese cattle which had passed through an attack of rinderpest during the immunization process were hyperimmunized with fixed tissue extract obtained from three different animals. These extracts were prepared in 0.5 per cent phenol and were 5 days old. Thirteen of the animals received 1,500 cubic centimeters each of this extract and one received 1,200 cubic centimeters. None of these animals developed any serious effects from these injections. They had a slight tem-

perature the day following the injections, which soon subsided to normal. After several days these animals were bled approximately 4 liters each to obtain serum which has been used in the immunization stations with good results.

In view of the results obtained in hyperimmunizing the Chinese cattle with the extracts, Dr. Youngberg had it tried on some animals in the provincial immunization stations. The extract was prepared at the research laboratory, using liver, spleen, lymphatics and heart in a 0.75 per cent phenol solution. On the fourth day of extraction this material was filtered through gauze and placed in 15-liter demijohns. When it was 6 days old it was taken by automobile to the San Fernando and the Apalit immunization stations. On the following day Dr. C. H. Leavitt, in charge of the San Fernando immunization station, injected five animals with 2,000 cubic centimeters each of this extract and Dr. C. H. Decker, in charge of the Apalit immunization station, injected four animals with 2,000 cubic centimeters each.

Dr. Leavitt states that a short time after the injection the animals became stiff, stopped eating, and in the course of a couple of days they presented the appearance of being paralyzed. All five of the animals he injected died. Dr. Decker had a somewhat similar experience and lost two of the four animals.

We then tried the same type of extract at the laboratory on two animals which had recently recovered from rinderpest. These animals were each injected with 2,000 cubic centimeters of a 7-day-old extract in 0.75 per cent phenol solution. In contrast to the above extracts, this material had been kept in the refrigerator up to the time of injection. These animals developed a pronounced oedema in the pendent portion of the body, which completely subsided in three days time by the aid of slight massaging and the application of warm water each morning. In four days time these animals were in normal condition and never presented any ill effects from the injections up to the time they were bled to death for serum.

From the results thus obtained it is quite evident that small Fuga and Batanes cattle can withstand 2,000 cubic centimeters of this extract at an injection without any serious disturbance.

A further test was made in trying to locate the cause of the losses incurred by Doctors Leavitt and Decker. In this experiment the extracts were made in a similar manner to those described above. On the sixth day they were placed in a demijohn and taken to San Fernando, Pampanga, by automobile and returned to the laboratory the following morning. This was done to expose the extracts to climatic conditions in the same

way that the extracts used by Doctors Leavitt and Decker had been exposed.

Two thousand cubic centimeters of this material was injected into a Batanes bull which had recently recovered from rinderpest. This animal developed an oedema similar to the others. By massaging and giving a warm bath the oedema had practically subsided by the fourth day. On the morning of the fifth day after injection this animal could not rise to its feet but continued to ruminate and ate a little during the morning. In the evening it was practically paralyzed and was found dead the next morning. From the results obtained in this experiment and those obtained by Doctors Leavitt and Decker it is quite evident that by exposing these extracts to the climatic conditions existing in the Philippines for a period of twenty-four hours, they pass through certain chemical changes which are very detrimental to animals receiving the extracts in large quantities. The exact changes have not been determined, but they would appear to be protein decomposition, or botulism toxin.

We are doing further work on trying to eliminate the small particles of tissue which pass through the gauze, by first filtering the extract through gauze then through a layer of cotton similar to the method used in filtering agar, and finally passing it through filter paper. By this method we obtain a slightly turbid, dark, amber-colored liquid. A small Fuga bull which recently recovered from rinderpest has been injected with 2,000 cubic centimeters of this material which was kept in the refrigerator up to the time of injection. This material caused a much milder oedema which practically subsided in two days and the animal suffered no apparent ill effects. There was a slight elevation of temperature for two days but the animal continued to eat well and looked bright.

## CONCLUSIONS.

1. Considering the results thus far obtained it is quite evident that tissue extracts from animals suffering with rinderpest are just as potent as virulent blood when used in simultaneous immunization work.

2. Any of the methods advocated for increasing the production of virulent material can be utilized, after which the organs can be extracted, thereby obtaining a much greater increase in quantity.

3. By using Martoglio's method and extracting the organs the output of virulent material is practically tripled.

4. If the extracts are kept at a temperature of approximately 15° Centigrade they can be used with safety in 2,000 cubic centimeter doses for hyperimmunization.

5. Considering our results up to date the extracts should not be given in massive injections if they have been exposed for a period of eighteen hours to the climatic conditions found in the Tropics.

6. These extracts can be produced so easily that this method can be used in any immunization station.

7. Considering the similarity of hog cholera to rinderpest this method should be as applicable in that disease as it is in rinderpest, thereby reducing the enormous cost of the virus.

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# ANOTHER PHILIPPINE CITRUS FRUIT.[1]

By P. J. WESTER, *Agricultural Advisor, Department of Mindanao and Sulu.*

The Philippines already hold first rank in the number of indigenous forms of the genus *Citrus,* several of which are additions to the citrus fruits, others being merely of botanical interest, and this very fact is a promise of discovery of still unrecorded species in the less explored regions of the Archipelago. Aside from a purely botanical point of view, new forms are at present also of great interest to the fruit grower and plant breeder as opening up new possibilites in hybridization, especially in connection with the problem of breeding new types resistant or immune to the citrus canker, *Pseudomonas citri* Hasse.

The "miaray" described and named below was found by the writer in August, 1917, in Impolutao in the interior of the Province of Bukidnon, Mindanao, at an elevation of 750 meters.

With its willowy, slender, drooping branches and dense crown of dark-green foliage, the miaray (pron. meeáray) is an exceedingly handsome ornamental tree. The fruit is about the size of a lime, not unlike an immature orange, usually growing singly in the axils of the leaves. It is pleasantly acid and may be used like the lime. The pubescence on the twigs is one of the interesting features of the miaray in a genus where nearly all species are glabrous. The foliage is more reminiscent of the mandarin than any other species and it is hoped that this apparently new form will prove as resistant to the citrus canker as the mandarin.

The clean, vigorous growth of the tree indicates that it is likely to prove a desireable stock for other cultivated varieties of the citrus fruits.

While too much reliance cannot be placed on this statement it is said by the native inhabitants in Impolutao that the miaray grows wild in the forests of Bukidnon, whence it has been brought under cultivation, and it is said to be grown in various

[1] For descriptions of other Philippine citrus fruits see this REVIEW, Vol. VIII, No. 1, 1915, p. 5; Vol. X, No. 2, 1917, p. 104.

other municipalities of the province. At any rate, the writer, who has devoted considerable time to the study of the Philippine citrus fruits, has never found this form in any other part of the Islands, and he believes it sufficiently distinct from all others to deserve rank as a separate species.

*Citrus miaray* n. sp. MIARAY.

A handsome tree about 6 meters in height, with a dense crown of dark-green foliage and slender, willowy, drooping branches; young growth pubescent, the hairs remaining on the twigs and the midrib beneath even some time after those attaining maturity; spines small and rather weak, frequently absent; leaves averaging 8 to 12 centimeters in length, rarely exceeding 16 centimeters, 35 rarely more than 55 millimeters wide, elliptical oblong or ovate to lanceolate, somewhat undulate, more conspicuously crenate on apical half; base broadly acute; apex almost caudate, slightly margined. Flowers not seen. Fruits axillary, usually solitary, rarely germinate, 32 to 38 millimeters long, 35 to 40 millimeters in equatorial diameter; form slightly oblate, compressed towards base, flattened at apex, commonly with a slight circular depression around stigmatic area; skin medium thick, smooth, adhering to flesh; locules nearly always 10, very rarely 9, adherent to each other; juice cells rather small; flesh greenish gray, sharply but pleasantly acid, rather recalling the lemon; juice quite abundant; seeds comparatively large.

# CURRENT NOTES—FOURTH QUARTER.

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NOTES BY C. W. HINES, Sugar Technologist.

## CANE CROP.

The local cane crop of this year has made a most excellent growth thus far notwithstanding the fact that it received a sligth excess of rain during the early part of the season in several of the sugar districts.

It is somewhat early to predict with any degree of accuracy the yield for this year since late typhoons and ravages by locusts often cause a decided difference in the yield even a short time before the harvest period. Should favorable conditions prevail the crop this year will amount to between three hundred and thirty, and three hundred and fifty tons, which is slightly below normal.

One thing of interest in connection with the cane crop is the fact that the ratoon cane is better than usual. This may be attributed partly to the fact that through the efforts of the Bureau of Agriculture demonstration stations, attention was given to the ratoon crop from the time the previous crop was harvested until the cane was laid by. The system of leaving the trash over the ground in the form of a heavy mulch instead of burning it off as usual has caused an increased growth during the dry season due to the moisture-retaining qualities of this mulch.

## SUGAR MARKET.

The sugar market has been rather dull for some time due largely to the lack of sufficient ocean transportation to America. While there is still a great deal of sugar in the various warehouses there have been few buyers wiling to offer more than a nominal price since there is but a limited number of vessels making this trip and the freight rates are subject to very great fluctuations.

The supply of low grades of sugar used locally is nearly exhausted. These sugars have brought a very low price as compared with the market price of good sugars.

During the last quarter there has been exported 66,372 metric tons of crude sugar, while 45 tons of refined sugar were imported during the same period.

### RAINFALL.

During the months of July, August, and September, the heart of the rainy season, there have been very few heavy storms in the sugar districts and consequently the cane is much more nearly erect than it usually is at this season of the year. There was a normal amount of rain reported in July and the forepart of August but since that time until October an unusually dry spell prevailed for this season of the year. In normal years the ground is usually so wet that it is impossible to do any plowing. This year, as a contrast, the work of plowing has been conducted almost constantly on the various plantations and much land has been already prepared for planting.

### ANOTHER MUSCOVADO FACTORY CONVERTED INTO CENTRIFUGAL FACTORY.

While the most economical results are obtained at those factories possessing large units it is impossible for more than a small portion of the cane planters to avail themselves of such opportunities due to the limited number of modern factories operating here. As a consequence several muscovado factories have been converted into centrifugal factories by the addition of vacuum evaporators, crystallizers, and centrifugals. These have invariably given better results than the open-kettle factories as the centrifugal sugar which they manufacture meets with a ready market as well as commanding a good price. One of the latest factories to be reconstructed is located in the Province of Pampanga near the Dinalupihan Centrifugal Factory, which is the second factory of its type in that province.

### LOW PRICE OF ALCOHOL.

There is at present quite a large supply of alcohol on hand and very few shipments of any but the highest grades have been made for export. Due to the high freight rates prevailing at present it has been found impracticable to ship the product at a profit for any great distance and its use locally as a substitute for gasoline has but recently come into effect. The alcohol from the extensive nipa swamps as well as that from the waste molasses of the centrifugal factories can entirely replace gasoline when appliances for the use of alcohol are more generally employed.

## JAVA CANE VARIETIES.

A number of Java seedling varieties were imported during November, 1916. Several of these have made excellent growth and indications are that they will yield heavily in cane but their sucrose content cannot be determined for several months yet until the cane has reached complete maturity. The varieties which have made a particularly good showing are J–100, 213, and Black Cheribon. The J–247 variety, which has been under observation for some time at one of the experiment stations, has yielded heavily in cane and on account of its hard tissue it resists wind storms. Nevertheless this cane is subject to splitting during rapid growth which causes an appreciable lowering of the sucrose as well as of the purity coefficient to the juice.

## SEEDLING VARIETIES.

Careful observations have been continued on the Philippine seedling varieties and it has been observed that many of these varieties which are now nearly two years old offer every assurance of being heavy yielders of cane. Some of these have extremely long internodes, which is a characteristic in their favor. Analytical testing of these varieties will be started during the latter part of November and continued for several months or until the supply of each variety is exhausted. The tips of this cane when cut for the analytical tests will be immediately planted and in this manner it will be possible to conduct the work with a very limited supply of cane. The seedling varieties from the past year now range from one-half meter to one meter in height and these have made a most excellent growth since being transplanted from the bamboo tubes.

## IMPROVEMENT IN THE EQUIPMENT OF CALAMBA.

Due to the extensive crop before the large Calamba Sugar Factory it has been found necessary to increase the boiling house of that factory by the addition of another quadruple effect of the same diameter as the original. This factory is now capable of handling approximately 2,000 tons of cane per day, though the average grind will no doubt be slightly lower than that figure. Their crop this year shows every indication of being extra large unless something unforseen happens before the harvest begins, and it will no doubt exceed that of last year The previous crop surpassed all expectations with a total output of direct and remelt of over 30,000 tons of sugar.

## PROPOSED GOVERNMENT SUGAR CENTRALS.

The project of building Government sugar centrals has been temporarily abandoned due to the extremely abnormal conditions prevailing at present. A plan was devised for successfully financing this work but it was found to be extremely difficult, not to say impossible, to purchase and transport the heavy machinery when there are scarcely enough steamers to bring necessary commodities to these Islands. There is no loss of interest on the part of the Government or of the sugar planters where these factories were to be built and as soon as normal conditions again prevail this project will be pushed with renewed activity. In addition to the Government projects there will be numerous factories built by the various corporations, which are at present collecting all of the necessary data to aid them in the proper design of mills specially suited to each particular district. The sugar section of this Bureau has rendered valuable assistance to these promoters by carrying on special investigations in the various districts, and in addition the sugar laboratory has compiled data which will be of value in the new projects when this work is again resumed.

## METHODS OF PAYMENT FOR CANE IN THE PHILIPPINES.

There are three methods employed in purchasing sugar cane at the various factories throughout the Philippines, as follows:

First: The cane is purchased at a fixed price per metric ton without regard to the quality of the product.

Second: Payment is made in accordance with a stipulated percentage of the sugar obtained from the cane. This usually ranges roughly from 45 to 60 per cent of the finished sugar, depending upon the conditions obtaining at the time the contract was made. The new contracts are invariably made on a basis of fifty-fifty, that is, the sugar is equally divided between the cane grower and factory and a similar division is made of the molasses.

Third: This is by far the fairest system to both the factory and planter when the proper rate of payment obtains. In this system a certain fixed price is paid for cane which has a stipulated available sugar content in the nominal juice from mature cane, and for all sugar obtained above this amount a proportionate increase is made in the price, while a proportionate deduction is made for cane yielding below that figure. While this system is reasonably fair when the proper rate of payment is agreed upon yet in these abnormal times when conditions

change so quickly it offers serious objections in that one side or the other is likely to be prejudiced.

The writer considers that a fairer system under present conditions consists of having the company responsible for the manufacture and sale of the sugar and after the manufacturing and selling expenses are deducted from the total amount received for the sugar, the remainder is divided equally between the factory and planter. When it is necessary to haul the cane a great distance, such expenses should likewise be shared by both parties.

### NORIT METHOD OF MAKING WHITE SUGAR.

Work is progressing rapidly at the local sugar refinery where installments of the necessary apparatus for the Norit system of making sugar have been received. It is hoped that this vegetable carbon will accomplish all that the parties claim for it and that it will in a short time replace the bone-black which is both expensive and hard to procure.

### DIFFICULTY IN SECURING LIME FOR JUICE CLARIFICATION.

The approach of the grinding season with the large crop of cane before the planters and the difficulty of securing supplies has caused the large factories no little trouble in securing among other necessities high-grade quicklime for the clarification of their juices. Heretofore this material has been imported largely from Japan but on account of the lack of transportation as well as on account of the high freight rates it has been somewhat difficult to provide an ample supply for the crop. It is thought that much of this material will be produced locally before the approach of another grinding season as the money now spent abroad for this material would go a long way toward the construction of suitable kilns for its production here.

### MANUFACTURE OF PLANTATION WHITE SUGAR.

An increasing amount of plantation white sugar is produced locally each year. Since there is but one refinery operating here it is necessary to either import high-grade sugar from America and Hongkong to make up the deficit or to produce this material directly on the plantations. The high over-sea freight rates have made the importation of sugar rather expensive and consequently little is brought in at present. This condition, however, assists in the sale of plantation white sugar even though the color is quite often unfavorable due to the fact that too little attention is usually paid to the clarification of the juices for the manufacture of a good grade of sugar. With the

high purity of the juices obtained here it is a comparatively simple matter to make a high-grade sugar from these juices. In fact, during the tests by this Bureau at various factories it has been demonstrated that but a limited amount of lime and sulphur was required to bring about the desired result.

### CARBON FROM RICE HULLS IN DECOLORIZING SUGAR SOLUTIONS.

Great success has been attained in the bleaching of cane juices with the vegetable carbon from rice hulls. There is an abundance of this material produced here every year and the writer was induced to test out this decolorizing power on various cane juices after the announcement was made through The Louisiana Planter of the successful experiments conducted by Dr. W. G. Tagart, Director of the Sugar Experiment Station of Lousisiana.

Practically all of the decolorizing and bleaching reagents used here are imported from abroad and it is hoped that these recent experiments will solve an important problem for the local manufacturers of high-grade sugars.

### FEED FOR PLANTATION ANIMALS.

The impending shortage of feed for work animals is causing the planters to take a deeper interest in the use of Uba forage cane. This cane has given excellent results particularly on low lands. The general practice is to plant only a small plot of this forage on each plantation in order to supply the work animals until the harvest of the cane crop begins, during which time there is an abundance of feed from the cane tops. Thousands of points of the Uba cane have already been distributed to the various planters from the Alabang Experiment Station where this Bureau maintains a field exclusively for the production of cane for planting.

### NEW SYSTEM OF HANDLING RATOONS.

The article on the Root System of Sugar Cane and The Handling of Ratoon Crops, which appeared in this REVIEW, Vol. X, No. 2, has attracted much attention among cane planters here. As a result of these studies several planters are planning to divert from the old system of cultivating the ratoon stubble left after the first crop is harvested and after thoroughly preparing the land between the old cane rows to run a deep furrow through this region and to plant in the new furrows vigorous rhizomes from the lower portion of the old root system of the previous crop. This system will permit the planters to select only the most vigorous rhizomes and prevent the weaker plants from drawing upon the food supply. It will also permit

the production of larger stalks to the hill, since the cane will be grown in soil which is not deprived of its plantfood material from the growth of previous crops as was the case with the old system of handling ratoons.

### USE OF MOLASSES FOR FEED.

There is an increasing amount of molasses used for feeding animals in this country due to the high price of corn and palay (unhulled rice). In feeding the molasses it is mixed with various chopped feeds, especially with tiqui-tiqui (rice polish). This makes an excellent feed for practically all classes of animals when properly combined with protein-bearing feeds. The price usually paid for molasses in Manila ranges from $0.25 to $0.50 per five-gallon can.

### DIFFICULTY IN SECURING SUGAR BAGS.

There has been a great deal of difficulty experienced in securing the necessary sugar bags for the coming crop. Although there are various vegetable fibers produced in abundance here none of this material is manufactured into bags. This is an industry worthy of consideration as it would mean very much to the planters to have their sugar bags produced locally.

### INCREASE USE OF LOW-GRADE SUGAR.

While the price of the various food stuffs has gradually increased until in many cases it is practically double what it was in antebellum days, the price of low-grade sugar has remained practically constant. As a consequence the poorer classes are using larger quantities of this food every day. There is no good reason why carbohydrates from sugar cannot successfully replace that material from some of the more expensive foods, since this is one of the most concentrated foods and is easily digested by most persons.

### AUXILIARY CROPS ON SUGAR PLANTATIONS.

The various sugar plantations are planning to use a limited amount of space for the production of auxiliary crops to supply feed for the animals and thus eliminate as much as possible the purchase of such material as corn and rice. The various native legumes as well as the imported cowpeas will be planted in greater abundance in order to provide food for the laborers and feed for the plantation animals, as well as to supply the much needed nitrogen to the soil. There is no secondary crop grown on the sugar plantations which brings greater results to the planters here than the legumes.